

# DEPARTMENT OF INTEGRATIVE BIOLOGY

## Mission Statement

The mission of the Department of Integrative Biology is to educate, inspire, and assist students and regional diverse populations through a comprehensive curriculum, emergent pedagogy, and collaborative research. We focus on the complexity and factors that influence life and we strive to understand how the processes that sustain life and enable biological innovation operate and interact within and across different scales of organization: from molecules to cells, tissues to organisms, species, ecosystems, biomes, and the Earth.

## General Information

Faculty conduct research related to how environments affect cells, microbes, plants, animals, and ecosystems. Researchers' interests range from cell growth, development, and reproduction, to the effects of hormones on plant growth and plant development, to signaling between plants, to ecology. The department also has a strong core of faculty interested in the conservation and restoration of our natural resources, including soil health, river restoration, and wildlife habitat.

## Degrees

The Department of Integrative Biology offers the following degrees:

- Bachelor of Science degree in Biology
  - Concentration in Cell and Molecular Biology
  - Concentration in Ecology
  - Concentration in Plant Biology
  - Concentration in Premedical Sciences
  - Concentration in Grades 7–12 Biology Teacher Certification in collaboration with UTeachSA.
- Bachelor of Science degree in Environmental Science
- Bachelor of Arts degree in Environmental Studies
- Bachelor of Science in Multidisciplinary Science with Grades 7–12 Science Teacher Certification (in collaboration with UTeachSA)
- Minor in Biology
- Minor in Environmental Science

To create a well-rounded graduate, students are encouraged to get involved in research and outreach activities as soon as possible.

## Educational Objectives

Upon graduation, students in Department of Integrative Biology programs will be able to:

- Explain foundational concepts related to the specific degree.
- Apply the process of scientific inquiry.
- Demonstrate critical thinking skills.
- Use appropriate field and/or laboratory methods to collect quality data.
- Use appropriate quantitative and qualitative methods to evaluate scientific data.
- Demonstrate ability to work effectively in a team with others from diverse disciplines and backgrounds.

- Effectively communicate scientific information, and the relationship between science and society, to a diverse audience through oral, written, and visual means.

## Health Careers Pathways

The Department of Integrative Biology offers programs that supports students interested in pursuing professional or graduate programs (e.g., medical, dental, pharmacy and veterinarian) in health-related professions. See the Degrees (p. 1) page for more information. Students can also visit the UTSA Health Professions office (<https://www.utsa.edu/healthprofessions/>) for more information.

## Sophomore Biology Research Initiative (SBRI)

The Sophomore Biology Research Initiatives offers eligible second-year students to engage in authentic research with faculty and graduate students while earning academic credit. The opportunity to be part of the SBRI is limited, so students should register early. See the Degrees (p. 1) page for more information about SBRI.

- B.S. Degree in Biology (p. 1)
  - Concentration in Cellular and Molecular Biology (p. 4)
  - Concentration in Ecology (p. 4)
  - Concentration in Plant Biology (p. 4)
  - Concentration in Premedical Sciences (p. 4)
  - Concentration in 7-12 Biology Teacher Certification (p. 5)
- B.S. Degree in Environmental Science (p. 9)
- B.A. Degree in Environmental Studies (p. 13)
- B.S. Degree in Multidisciplinary Science (p. 15)

## Bachelor of Science Degree in Biology

The Bachelor of Science (B.S.) Degree in Biology is designed to prepare students for professional careers in the biological sciences, medical and health service fields, research, industry, and education. For students planning to attend medical, dental, or graduate school in biological and applied sciences, this major provides a strong foundation in the basic life sciences. The program of study is structured around a comprehensive curriculum that includes genetics, physiology, cell biology, chemistry, physics, computer science, and mathematics. This foundational knowledge along with laboratory experience prepares students for research and technical positions in universities, government, and industry. At the upper-division level, students wanting to specialize can choose from five concentrations: Cellular and Molecular Biology, Ecology, Plant Biology, Premedical Sciences, and Grades 7–12 Biology Teacher Certification. The degree also offers a pathway to Physical Therapy doctoral programs and Physician Assistance master's programs.

Some of the careers a B.S. Degree in Biology will prepare students for are animal scientist, biochemist, bio-engineer, biometrician, botanist, chiropractor, dentist, ecologist, food scientist technologist, forester, medical librarian, medical technologist, microbiologist, molecular biologist, neurobiologist, ophthalmologist, optometrist, pharmaceutical salesperson, pharmacy technician, physical therapist, physician, physician assistant, radiation technologist, research scientist, science teacher, park naturalist, test and inspection technician, veterinarian, wildlife biologist, zoologist, or a zoo or aquarium administrator.

The minimum number of semester credit hours required for the B.S. degree in Biology, including the Core Curriculum requirements, is 120. To

complete the Grades 7-12 Biology Teacher Certification Concentration requires a minimum of 124 semester credit hours.

Thirty-nine of the total semester credit hours required for the degree must be at the upper-division level.

All major and support work courses and the required prerequisites must be completed with a grade of "C-" or better.

## Program Outcomes

Graduates of the B.S. Degree in Biology program will be able to:

- Explain foundational concepts in biology, including evolution, cell theory, the chemical basis of life, expression and transmission of genetic information, energy transfer and transformation, integration of living systems, and species diversity.
- Explain the relationship between structure and function at all levels of biological organization, including molecular, cellular, organismal, population, and ecosystem levels.
- Apply the process of scientific inquiry.
- Use appropriate field and/or laboratory methods to collect quality data.
- Use appropriate quantitative and qualitative methods to evaluate biological data.
- Demonstrate critical thinking skills in relation to biological issues.
- Demonstrate ability to work effectively in a team with others from diverse disciplines and backgrounds.
- Effectively communicate scientific information, and the relationship between science and society, to a diverse audience through oral, written, and visual means.

## Sophomore Biology Research Initiative

Students may apply to participate in the Sophomore Biology Research Initiative. After acceptance, students will take BIO 2953 Special Topics in Biology followed by BIO 3053 Sophomore Research Experience during their sophomore year after completing their first 30 hours. Students should apply after their first semester. A total of six hours will be completed. BIO 2953 Special Topics in Biology will replace the required laboratories Molecular Genetics Laboratory (BIO 2362) and Molecular Biochemistry Laboratory (BIO 3362). During their junior year, students are encouraged to take BIO 3382 Sophomore Research Initiative Peer Mentor and serve as a mentor to sophomore students. SBRI allows students to engage in authentic research with faculty and graduate students. Students working in teams will conduct their research projects on a specific biological problem over two semesters. Several different research topics will be available to choose from. There will be approximately two hours of lecture/lab meeting and six hours of lab work per week. Students will present their final data in poster format at an organized symposium. The opportunity to be part of the SBRI is limited, so students should register early.

## Health Career Pathways

For those students interested in using a biology degree as a pathway to health-related professional school, **it is important to remember that each medical, dental, or other health-related professional school determines its course requirements for admission.** There is a significant similarity within each of these professional schools, but differences do occur. Students should refer to the respective school of interest website for the official and most current requirements for that particular school.

For those students interested in medical, dental, and veterinarian schools in Texas, the Concentration in Premedical Sciences offers the prerequisites required for most Texas schools as well as other courses to prepare students for these professional schools. Visit the Texas Medical & Dental Schools Application Service (<https://www.tmdsas.com/>) website for more information and a list of the general requirements.

Please see our website for a curriculum map for pathways to a career as a physical therapist or a physician assistant. For more information about physical therapy graduate programs in Texas visit Texas Physical Therapy Association (<https://www.tpta.org/pt-schools/>). Information about physician assistant studies in Texas can be found at the Texas Academy of Physician Assistants ([https://www.tapa.org/AMSIMIS/TAPA/Student\\_Center/Texas\\_PA\\_Programs.aspx](https://www.tapa.org/AMSIMIS/TAPA/Student_Center/Texas_PA_Programs.aspx)).

Students can also visit the University's Health Professions office at <https://www.utsa.edu/healthprofessions/>.

## Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. Degree in Biology must complete University Core Curriculum requirements in the same manner as other students. The courses listed below satisfy both degree requirements and Core Curriculum requirements; however, if these courses are taken to satisfy both requirements, then students may need to take additional courses to meet the minimum number of semester credit hours required for this degree.

- MAT 1193 may be used to satisfy the Core Curriculum requirement in the Mathematics Component Area as well as a major requirement. (Students in the Concentration in Grades 7-12 Biology Teaching Certification can substitute STA 1053 for MAT 1193.)
- BIO 1203 Biosciences I for Science Majors, BIO 1223 Biosciences II for Science Majors, PHY 1943 Physics for Scientists and Engineers I or PHY 1963 Physics for Scientists and Engineers II may be used for the six hours of Core Curriculum requirement in Life and Physical Sciences Component Area, as well as major requirements.
- AIS 1263 AIS: Life and Health Sciences is required for the Core Curriculum requirement in the First Year Experience Component Area.
- ENG 2413 Technical Writing is required as a major requirement and satisfies the Core Curriculum requirement in the Core Component Option.
- PSY 1013 Introduction to Psychology is required for the Concentration in Premedical and satisfies the Core Curriculum requirement in the Social and Behavioral Component Area.

Core Curriculum Component Area Requirements (<http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/>)

First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3

Component Area Option	3
<b>Total Credit Hours</b>	<b>42</b>

## Gateway Courses

Students pursuing the B.S. Degree in Biology must complete each of the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change his or her major.

Code	Title	Credit Hours
BIO 1203	Biosciences I for Science Majors	
BIO 1223	Biosciences II for Science Majors	
BIO 2313	Genetics	

## Degree Requirements

Code	Title	Credit Hours
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### A. Required courses in the major

1. Biology requirements: 20

BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors	
BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors	
BIO 2313	Genetics	
BIO 3413	General Physiology	
BIO 3513	Biochemistry	
BIO 3813	Cell Biology (NDRB 3813)	

2. Advanced Laboratory options: 4-6

BIO 2362	Molecular Genetics Laboratory	
BIO 3362	Molecular Biochemistry Laboratory	
For Sophomore Biology Research Initiative Students		
BIO 2953	Special Topics in Biology (taken two times in consecutive semesters for a total of 6 hours)	

3. Biology electives:

Additional biology electives at the upper-division level 21

For students interested in focusing on computational biology, we recommend BIO 3523 Advanced Computational Biology and BIO 3253 R Coding in Environmental Science and Ecology

### B. Support work

The support courses listed below are mandatory prerequisites for various biology courses starting in a student's sophomore year. Students need to complete their support work as soon as possible, in their freshman and sophomore years, to be eligible to register for upper-division biology core courses and electives. Failure to complete the support courses listed below in a timely fashion will significantly delay a student's progress toward graduation.

1. Required chemistry courses: 16

CHE 1103 & CHE 1121	General Chemistry I and General Chemistry I Laboratory	
CHE 1113 & CHE 1131	General Chemistry II and General Chemistry II Laboratory	

CHE 2603 & CHE 2612	Organic Chemistry I and Organic Chemistry I Laboratory	
CHE 3643	Organic Chemistry II	

2. Required mathematics and statistics courses: 6

MAT 1193	Calculus for the Biosciences	
STA 1403	Probability and Statistics for the Biosciences	

Students pursuing the Concentration in Grades 7–12 Teacher Certification can substitute STA 1053 for both MAT 1193 and STA 1403.

3. Required physics courses selected from one of the following options: 8

Option 1

PHY 1603 & PHY 1611	Algebra-based Physics I and Algebra-based Physics I Laboratory *	
PHY 1623 & PHY 1631	Algebra-based Physics II and Algebra-based Physics II Laboratory *	

Option 2

PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory *	
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory *	

4. Required computer science course: 3

BIO 1173	Introduction to Computational Biology	
or CS 1173	Data Analysis and Visualization	

5. Required communication courses 6

ENG 2413	Technical Writing (also satisfies core requirement)	
COM 2113	Public Speaking	

### C. Free electives

Select 6 semester credit hours of free electives, depending on the laboratory sequence chosen under section A2, to complete 120 hours. 1-4 credit hours must be at the upper-division level to reach the minimum requirement of 39 upper-division semester credit hours.

Students pursuing the Concentration in Grades 7–12 Teacher Certification will take required courses for teacher certification in lieu of free electives (see concentration requirements below).

Students interested in focusing on computational biology should take ES 2113 - Geographical Information Systems

**Total Credit Hours** 90-92

\*Note: Students in the Concentration in Grades 7-12 Teaching Certification have a defined program of study outlined below.

Physics laboratories noted by an asterisk (\*) are not required for the Concentration in Grades 7-12 Teaching Certification.

## Concentrations

For students interested in research, teaching, graduate, or professional programs, the Department of Integrative Biology offers five concentrations. To declare a concentration or obtain advice, students should consult an undergraduate advisor in Life and Health Sciences Advising. If a student takes any of the courses listed below that satisfy the Biology degree and concentration, the student may need to take additional upper-division Biology courses to meet the minimum number of semester credit hours required for the Biology degree. Students who

do not satisfy all requirements of a given concentration will receive a general B.S. Degree in Biology.

### Concentration in Cell and Molecular Biology

The coursework within the Concentration in Cell and Molecular Biology must be completed with a minimum cumulative grade point average of 3.0 or better. Students are also encouraged to enroll in BIO 4923 Laboratory Research: Biology Concentrations as part of their program of study. More information can be found in the Department of Neurosciences, Development and Regenerative Biology. (<http://catalog.utsa.edu/undergraduate/sciences/neuroscience/>)

All candidates for the Concentration in Cell and Molecular Biology must complete the following:

Code	Title	Credit Hours
BIO 3913	Molecular Biology	3
or NDRB 3913	Molecular Biology	
BIO 3663	Human Embryology	3
or NDRB 3663	Human Embryology	
Select three of the following:		9
BIO 3933	Principles of Cancer Biology	
or NDRB 3993	Principles of Cancer Biology	
BIO 4143	Developmental Biology	
or NDRB 4143	Developmental Biology	
BIO 4453	Endocrinology	
or NDRB 4453	Endocrinology	
BIO 4723	Virology	
or MMI 4723	Virology	
BIO 4743	Immunology	
or MMI 4743	Immunology	
BIO 4923	Laboratory Research: Biology Concentrations (Research must be in a laboratory engaged in molecular biology research.)	
or MMI 4923	Laboratory Research	
or NDRB 4923	Laboratory Research	
NDRB 3463	Brain Diseases	
NDRB 4153	Frontiers in Pluripotent Stem Cells	
NDRB 4483	Developmental Neuroscience: From Zygote to Brain Circuits	
<b>Total Credit Hours</b>		<b>15</b>

### Concentration in Ecology

The coursework within the Concentration in Ecology must be completed with a minimum cumulative grade point average of 3.0 or better. Students are also encouraged to enroll in BIO 4923 Laboratory Research: Biology Concentrations as part of their program of study.

All candidates for the Concentration in Ecology must complete the following:

Code	Title	Credit Hours
BIO 3283	Principles of Ecology	3
BIO 3292	Principles of Ecology Laboratory	2
Select three of the following:		9
BIO 3073	Environmental Rhetoric and Technical Communication	

BIO 3113	Ichthyology
BIO 3213	Animal Behavior
BIO 3233	Survey of Insects
BIO 3253	R Coding in Environmental Science and Ecology
BIO 3293	Mammalogy
BIO 3303	Entomology
BIO 3323	Evolution
BIO 3353	Herpetology
BIO 4033	Conservation Biology
BIO 4053	Wildlife Ecology
BIO 4063	Ornithology
BIO 4233	Field Biology
BIO 4263	River Ecosystems
BIO 4273	Fish Ecology
BIO 4283	Plant-Soil-Microbe Interactions
BIO 4303	Aquatic Ecology
BIO 4323	Restoration Ecology
BIO 4773	Microbial Ecology and Metagenomics
BIO 4923	Laboratory Research: Biology Concentrations (Research must be in a laboratory engaged in ecological research.)

**Total Credit Hours** **14**

### Concentration in Plant Biology

The coursework within the Concentration in Plant Biology must be completed with a minimum cumulative grade point average of 3.0 or better. Students are also encouraged to enroll in BIO 4923 Laboratory Research: Biology Concentrations as part of their program of study.

All candidates for the Concentration in Plant Biology must complete the following:

Code	Title	Credit Hours
BIO 3343	Plant Cell Biology	3
BIO 4313	Plant Physiological Ecology	3
Select three of the following:		9
BIO 3263	The Woody Plants	
BIO 3273	Biology of Flowering Plants	
BIO 3333	Plants and Society	
BIO 4283	Plant-Soil-Microbe Interactions	
BIO 4643	Medicinal Plants	
BIO 4923	Laboratory Research: Biology Concentrations (Research must be in a laboratory engaged in plant-based research.)	

**Total Credit Hours** **15**

### Concentration in Premedical Sciences

The B.S. degree in Biology with a Concentration in Premedical Sciences is designed to prepare students for professional programs in medicine, dentistry, pharmacy, or veterinary science. This concentration has a recommended curriculum that is designed to meet the requirements for entry into these professional schools and to prepare students for the MCAT, DAT, PCAT, or GRE examinations. The coursework within the Concentration in Premedical Sciences must be completed with a

minimum cumulative grade point average of 3.0 or better. All candidates for the Concentration in Premedical Sciences must complete the following:

Code	Title	Credit Hours
BIO 2992	Medical Terminology	2
BIO 3013	Introduction to Clinical Medicine and Pathology	3
or MMI 3013	Introduction to Clinical Medicine and Pathology	
BIO 3433	Neurobiology	3
or NDRB 3433	Neurobiology	
BIO 3643 & BIO 3642	Advanced Physiology I and Clinical Anatomy Laboratory I	5
BIO 3653 & BIO 3652	Advanced Physiology II and Clinical Anatomy Laboratory II	5
BIO 3663	Human Embryology	3
or NDRB 3663	Human Embryology	
BIO 3713	Microbiology	3
or MMI 3713	Microbiology	
BIO 4473	Advanced Clinical Medicine and Pathology	3
or MMI 4473	Advanced Clinical Medicine and Pathology	
PSY 1013	Introduction to Psychology (meets Core Curriculum requirement for Social and Behavior Component Area)	3
<b>Total Credit Hours</b>		<b>30</b>

### Concentration in Grades 7–12 Biology Teacher Certification

The B.S. degree in Biology with a Concentration in Grades 7-12 Biology Teacher Certification is designed to prepare students for professional careers in teaching Biology at the level of secondary education. The program of study is structured around a comprehensive Biology curriculum and state requirements for grades 7–12 life science teaching certification. Students cannot receive a B.S. degree with Teacher Certification without completing the teacher certification coursework. A student who does not complete the Biology teacher certification must transfer to the B.S. degree in Biology, B.S. in Neurosciences, or the B.S. degree in Microbiology and Immunology to receive a degree in Biology.

The minimum number of semester credit hours required for the B.S. degree in Biology with Teacher Certification, including the Core Curriculum requirements, is 124. Thirty-nine of the total semester credit hours required for the degree must be at the upper-division level. The coursework within the Concentration in Grades 7–12 Biology Teacher Certification must be completed with a minimum cumulative grade point average of 2.5 or better.

### Criminal Background Check

Teacher preparation programs at UTSA requires fieldwork in public schools. This requires that a student be able to pass a criminal background check conducted by the school districts. It is the responsibility of the student to determine if their criminal history background will present a problem before applying for admission to the teacher preparation program. Students with a problematic criminal history will encounter difficulty in completing any fieldwork requirements and may not be able to complete the program.

All candidates for the Concentration in Grades 7–12 Biology Teacher Certification must complete the following:

Code	Title	Credit Hours
BIO 3283	Principles of Ecology	3
BIO 3323	Evolution	3
BIO 3713	Microbiology	3
BIO 4813	Brain and Behavior	3
ESL 3083	Second Language Teaching and Learning for Grades 7-12	3
LTED 3773	Reading and Writing Across the Disciplines- Grades 7–12	3
SPE 3603	Introduction to Special Education	3
UTE 1111	Introduction to STEM Teaching Step 1	1
UTE 1122	Introduction to STEM Teaching Step 2	2
UTE 3023	Perspectives on Science and Mathematics	3
UTE 3203	Knowing and Learning in Mathematics and Science	3
UTE 3213	Classroom Interactions	3
UTE 4203	Project-Based Instruction	3
UTE 4646	Clinical Teaching	6
<b>Total Credit Hours</b>		<b>42</b>

### Course Sequence Guide for B.S. Degrees in Biology

#### B.S. in Biology – Recommended Four-Year Academic Plan for the General B.S. in Biology or Concentrations in Cell & Molecular Biology, Ecology, or Plant Biology.

See below for the recommended four-year plan for students accepted to the Sophomore Biology Research Initiative, Concentration in Premedical, or Concentration in Grades 7-12 Biology Teaching Certification.

This course sequence guide is designed to assist students in completing their UTSA general B.S. degree in Biology or with concentrations in Cell & Molecular Biology, Ecology, or Plant Biology. *This course sequence is only a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans.* Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. **Students may choose to take courses during Summer terms to reduce course loads during long semesters.**

#### First Year

Fall		Credit Hours
AIS 1203	Academic Inquiry and Scholarship (core)	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors (core and major)	4
CHE 1103 & CHE 1121	General Chemistry I and General Chemistry I Laboratory	4
WRC 1013	Freshman Composition I (core)	3
<b>Credit Hours</b>		<b>14</b>

#### Spring

BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors (core and major)	4
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CHE 1113 & CHE 1131	General Chemistry II and General Chemistry II Laboratory	4
MAT 1193	Calculus for the Biosciences (core and major)	3
WRC 1023	Freshman Composition II (core)	3
<b>Credit Hours</b>		<b>14</b>

**Second Year**

**Fall**

BIO 2313	Genetics	3
BIO 2362	Molecular Genetics Laboratory	2
CHE 2603 & CHE 2612	Organic Chemistry I and Organic Chemistry I Laboratory	5
STA 1403	Probability and Statistics for the Biosciences	3
ENG 2413	Technical Writing (core)	3
<b>Credit Hours</b>		<b>16</b>

**Spring**

BIO 1173	Introduction to Computational Biology	3
BIO 3813	Cell Biology	3
CHE 3643	Organic Chemistry II	3
Select one of the following:		4
PHY 1603 & PHY 1611	Algebra-based Physics I and Algebra-based Physics I Laboratory	
or		
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	
Social and Behavioral (core)		3
<b>Credit Hours</b>		<b>16</b>

**Third Year**

**Fall**

BIO 3413	General Physiology	3
COM 2113	Public Speaking	3
Select one of the following:		4
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	
or		
PHY 1623 & PHY 1631	Algebra-based Physics II and Algebra-based Physics II Laboratory	
American History (core)		3
Language, Philosophy & Culture (core)		3
<b>Credit Hours</b>		<b>16</b>

**Spring**

BIO 3513	Biochemistry	3
BIO 3362	Molecular Biochemistry Laboratory	2
Government-Political Science (core)		3
Creative Arts (core)		3
Upper-division BIO elective (3xx3)		3-5

For Concentration in Ecology take BIO 3283 and BIO 3292		
For Concentration in Cell and Molecular take BIO 3913 or NDRB 3913 Molecular Biology		
For Concentration in Plant Biology take BIO 3343 Plant Cell Biology		
<b>Credit Hours</b>		<b>14-16</b>

**Fourth Year**

**Fall**

Upper-division BIO elective	3	
Students in the Cell and Molecular Biology Concentration should take BIO 3663 or NDRB 3663 Human Embryology		
Upper-division BIO elective	3	
Upper-division BIO elective	3	
American History (core)	3	
Free upper-division elective	3	
<b>Credit Hours</b>		<b>15</b>

**Spring**

Upper-division BIO elective	3	
Upper-division BIO elective	3	
Upper-division BIO elective	3	
Free upper-division elective (to meet 120 hour minimum)	1-3	
Government-Political Science (core)	3	
<b>Credit Hours</b>		<b>15-13</b>
<b>Total Credit Hours</b>		<b>120</b>

Note: Some courses are only offered once a year; Fall or Spring. Check with the Department of Integrative Biology for scheduling of courses.

**B.S. in Biology – Recommended Four-Year Academic Plan for Students Participating in *Sophomore Biology Research Initiative*.**

This course sequence guide is designed to assist students in completing their UTSA B.S. Degree in Biology for students participating in the Sophomore Biology Research Initiative. *This course sequence is only a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans.* Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. **Students may choose to take courses during Summer terms to reduce course loads during long semesters.**

**First Year**

<b>Fall</b>		<b>Credit Hours</b>
AIS 1203	Academic Inquiry and Scholarship (core)	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors (core and major)	4
CHE 1103 & CHE 1121	General Chemistry I and General Chemistry I Laboratory	4
WRC 1013	Freshman Composition I (core)	3
<b>Credit Hours</b>		<b>14</b>

<b>Spring</b>		
BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors (core and major)	4
CHE 1113 & CHE 1131	General Chemistry II and General Chemistry II Laboratory	4
MAT 1193	Calculus for the Biosciences (core and major)	3
WRC 1023	Freshman Composition II (core)	3
<b>Credit Hours</b>		<b>14</b>

**Second Year****Fall**

BIO 2313	Genetics	3
BIO 2953	Special Topics in Biology (SBRI)	3
CHE 2603 & CHE 2612	Organic Chemistry I and Organic Chemistry I Laboratory	5
STA 1403	Probability and Statistics for the Biosciences	3
<b>Credit Hours</b>		<b>14</b>

**Spring**

BIO 3813	Cell Biology	3
BIO 3053	Sophomore Research Experience	3
CHE 3643	Organic Chemistry II	3
Select one of the following:		4
PHY 1603 & PHY 1611	Algebra-based Physics I and Algebra-based Physics I Laboratory	
or		
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	
Government-Political Science (core)		3
<b>Credit Hours</b>		<b>16</b>

**Third Year****Fall**

BIO 3413	General Physiology	3
BIO 3382	Sophomore Research Initiative Peer Mentor	2
COM 2113	Public Speaking	3
Select one of the following sequences:		4
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	
PHY 1623 & PHY 1631	Algebra-based Physics II and Algebra-based Physics II Laboratory	
American History (core)		3
<b>Credit Hours</b>		<b>15</b>

**Spring**

BIO 1173	Introduction to Computational Biology	3
BIO 3513	Biochemistry	3
BIO 4912	Independent Study	2

Government-Politics (core)	3	
Social and Behavioral (core)	3	
Creative Arts (core)	3	
<b>Credit Hours</b>		<b>17</b>

**Fourth Year****Fall**

Upper-division BIO elective	3	
Upper-division BIO elective	3	
Free upper-division elective	3	
American History (core)	3	
Creative Arts (core)	3	
<b>Credit Hours</b>		<b>15</b>

**Spring**

Upper-division BIO elective	3	
Upper-division BIO elective	3	
Upper-division BIO elective	3	
Free upper-division elective	3	
Language, Philosophy, & Culture (core)	3	
<b>Credit Hours</b>		<b>15</b>
<b>Total Credit Hours</b>		<b>120</b>

**B.S. in Biology – Recommended Four-Year Academic Plan for Concentration in Premedical Sciences.**

This course sequence guide is designed to assist students in completing their UTSA B.S. Degree in Biology with a Premedical Sciences Concentration. *This course sequence is only a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans.* Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. **Students may choose to take courses during Summer terms to reduce course loads during long semesters.**

**First Year****Fall**

AIS 1203	Academic Inquiry and Scholarship (core)	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors (core and major)	4
CHE 1103 & CHE 1121	General Chemistry I and General Chemistry I Laboratory	4
WRC 1013	Freshman Composition I (core)	3
<b>Credit Hours</b>		<b>14</b>

**Spring**

BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors (core and major)	4
CHE 1113 & CHE 1131	General Chemistry II and General Chemistry II Laboratory	4
MAT 1193	Calculus for the Biosciences (core and major)	3
WRC 1023	Freshman Composition II (core)	3
<b>Credit Hours</b>		<b>14</b>

**Second Year**

Fall		
BIO 2313	Genetics	3
BIO 2362 or BIO 2953	Molecular Genetics Laboratory (SBRI students should take BIO 2953) or Special Topics in Biology	2-3
CHE 2603 & CHE 2612	Organic Chemistry I and Organic Chemistry I Laboratory	5
STA 1403	Probability and Statistics for the Biosciences	3
ENG 2413	Technical Writing (core)	3
<b>Credit Hours</b>		<b>16</b>

Spring		
BIO 2992	Medical Terminology	2
BIO 3413	General Physiology	3
BIO 3813	Cell Biology	3
CHE 3643	Organic Chemistry II	3
PSY 1013	Introduction to Psychology (core)	3
<b>Credit Hours</b>		<b>14</b>

**Third Year**

Fall		
BIO 3013	Introduction to Clinical Medicine and Pathology	3
BIO 3643 & BIO 3642	Advanced Physiology I and Clinical Anatomy Laboratory I	5
Select one of the following sequences:		4
PHY 1603 & PHY 1611	Algebra-based Physics I and Algebra-based Physics I Laboratory	
or		
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	
American History (core)		3
<b>Credit Hours</b>		<b>15</b>

Spring		
BIO 3653 & BIO 3652	Advanced Physiology II and Clinical Anatomy Laboratory II	5
BIO 4473	Advanced Clinical Medicine and Pathology	3
Choose one of the following two series of courses:		4
PHY 1623 & PHY 1631	Algebra-based Physics II and Algebra-based Physics II Laboratory	
or		
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	
Government-Political Science (core)		3
<b>Credit Hours</b>		<b>15</b>

**Fourth Year**

Fall		
BIO 3513	Biochemistry	3
BIO 3362	Molecular Biochemistry Laboratory	2
BIO 3663	Human Embryology	3
BIO 3713	Microbiology	3
American History (core)		3
Creative Arts (core)		3
<b>Credit Hours</b>		<b>17</b>

Spring		
BIO 1173	Introduction to Computational Biology	3
BIO 3433	Neurobiology	3
COM 2113	Public Speaking	3
Government-Political Science (core)		3
Language, Philosophy, & Culture (core)		3
<b>Credit Hours</b>		<b>15</b>
<b>Total Credit Hours</b>		<b>120</b>

Note: Some courses are only offered once a year; Fall or Spring. Check with the Department of Integrative Biology for scheduling of courses.

**B.S. in Biology – Recommended Four-Year Academic Plan for Concentration in Grade 7-12 Biology with Teaching Certification.**

This course sequence guide is designed to assist students in completing their UTSA undergraduate B.S. Degree in Biology with a Grade 7-12 Biology Teaching Certification. *This course sequence is only a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans.* Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. Note: Some courses are only offered once a year; Fall or Spring. Check with the Department of Integrative Biology for scheduling of courses.

**First Year**

Fall		Credit Hours
AIS 1203	Academic Inquiry and Scholarship (core)	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors (core and major)	4
CHE 1103	General Chemistry I	3
CHE 1121	General Chemistry I Laboratory	1
UTE 1111	Introduction to STEM Teaching Step 1	1
WRC 1013	Freshman Composition I (core)	3
<b>Credit Hours</b>		<b>15</b>

Spring		Credit Hours
BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors (core and major)	4
CHE 1113	General Chemistry II	3
CHE 1131	General Chemistry II Laboratory	1
UTE 1122	Introduction to STEM Teaching Step 2	2



WRC 1023	Freshman Composition II (core)	3
Select one of the following:		3
MAT 1193	Calculus for the Biosciences (core)	
or		
STA 1053	Basic Statistics (core)	
<b>Credit Hours</b>		<b>16</b>

**Summer**

American History (core)		3
Government-Political Science (core)		3
<b>Credit Hours</b>		<b>6</b>

**Second Year****Fall**

BIO 2313	Genetics	3
CHE 2603	Organic Chemistry I	3
CHE 2612	Organic Chemistry I Laboratory	2
CS 1173	Data Analysis and Visualization (core and major)	3
Select one of the following:		3
PHY 1603	Algebra-based Physics I	
or		
PHY 1943	Physics for Scientists and Engineers I	
UTE 3203	Knowing and Learning in Mathematics and Science	3
<b>Credit Hours</b>		<b>17</b>

**Spring**

BIO 2362	Molecular Genetics Laboratory	2
CHE 3643	Organic Chemistry II	3
Select one of the following:		3
PHY 1623	Algebra-based Physics II	
or		
PHY 1963	Physics for Scientists and Engineers II	
UTE 3213	Classroom Interactions	3
Social & Behavioral Sciences (core)		3
<b>Credit Hours</b>		<b>14</b>

**Summer**

American History (core)		3
Government-Political Science (core)		3
<b>Credit Hours</b>		<b>6</b>

**Third Year****Fall**

BIO 3283	Principles of Ecology	3
BIO 3362	Molecular Biochemistry Laboratory	2
BIO 3513	Biochemistry	3
BIO 3713	Microbiology	3
UTE 3023	Perspectives on Science and Mathematics	3
<b>Credit Hours</b>		<b>14</b>

**Spring**

BIO 3413	General Physiology	3
BIO 4813	Brain and Behavior	3

ESL 3083	Second Language Teaching and Learning for Grades 7-12	3
LTED 3773	Reading and Writing Across the Disciplines-Grades 7-12	3
Language, Philosophy, & Culture (core)		3
<b>Credit Hours</b>		<b>15</b>

**Fourth Year****Fall**

BIO 3323	Evolution	3
BIO 3813	Cell Biology	3
SPE 3603	Introduction to Special Education	3
UTE 4203	Project-Based Instruction	3
Creative Arts (core)		3
<b>Credit Hours</b>		<b>15</b>

**Spring**

UTE 4646	Clinical Teaching	6
<b>Credit Hours</b>		<b>6</b>
<b>Total Credit Hours</b>		<b>124</b>

Note: Some courses are only offered once a year; Fall or Spring. Check with the Department of Integrative Biology for scheduling of courses.

## Bachelor of Science Degree in Environmental Science

The Bachelor of Science (B.S.) Degree in Environmental Science is designed for students interested in studying environmental problems from a scientific perspective. The major prepares students to deal with issues arising from the impact of human interaction on natural systems. The program of study is structured around a comprehensive curriculum that includes botany, zoology, geology, environmental statistics, geographical information systems, environmental law, soils, watershed processes, global change, fate and transport of chemicals, and environmental assessment. Students may choose to specialize further in one of four focus areas: 1) conservation and restoration ecology, 2) environmental management, 3) natural resources and wildlife management, and 4) aquatic sciences. Students will gain hands-on experience with many of the instrumental techniques used in environmental analysis and have the opportunity to engage in teamwork for field studies, excursions, and laboratory studies. There is a strong emphasis on producing graduates with well-developed oral and written communication skills who are capable of complex problem-solving.

Some of the careers a B. S. degree in Environmental Science will prepare students for are environmental biologist, environmental chemist, environmental consultant, environmental engineer, environmental geologist, environmental health and safety officer, environmental health officer, environmental lawyer, environmental manager, environmental science teacher, environmental scientist, environmental specialist, environmental technician, geographer, microbiologist, water quality scientist, or wildlife biologist.

The minimum number of semester credit hours required for the B.S. degree in Environmental Science, including the Core Curriculum requirements, is 120.

Thirty-nine of the total semester credit hours required for the degree must be at the upper-division level.

All major and support work courses and the required prerequisites must be completed with a grade of "C-" or better.

## Program Outcomes

Graduates of the B.S. Degree in Environmental Science program will be able to:

- Explain foundational concepts in environmental science, including plant and animal biology, ecosystem ecology, toxicology, conservation biology, environmental policy, geology, climate change, and human impacts on the environment.
- Evaluate issues related to the environment using an interdisciplinary and multidisciplinary course of study.
- Apply the process of scientific inquiry.
- Use appropriate field and/or laboratory methods to collect quality data.
- Use appropriate quantitative and qualitative methods to evaluate environmental data.
- Demonstrate critical thinking skills in relation to environmental issues.
- Demonstrate ability to work effectively in a team with others from diverse disciplines and backgrounds.
- Effectively communicate scientific information, and the relationship between science and society, to a diverse audience through oral, written, and visual means.

### Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. Degree in Environmental Science must fulfill University Core Curriculum requirements in the same manner as other students. If courses are taken to satisfy both degree requirements and Core Curriculum requirements, then students may need to take additional courses to meet the minimum number of semester credit hours required for this degree.

### Core Curriculum Component Area Requirements (<http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/>)

First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
<b>Total Credit Hours</b>	<b>42</b>

## Gateway Courses

Students pursuing the B.S. Degree in Environmental Science must complete each of the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change his or her major.

Code	Title	Credit Hours
CHE 1083	Introduction to the Molecular Structure of Matter	3
CHE 1093	Introduction to Molecular Transformations	3
MAT 1093	Precalculus	3

## Degree Requirements

Code	Title	Credit Hours
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### A. Required environmental science courses (54 hours of which 6 are in the core) 54

Must be completed with a grade of "C-" or better		
ES 1113 & ES 1111	Environmental Botany and Environmental Botany Laboratory	
ES 1123 & ES 1121	Environmental Zoology and Environmental Zoology Laboratory	
ES 1213 & ES 1211	Environmental Geology and Environmental Geology Laboratory	
ES 1314	Environmental Statistics	
ES 2013 & ES 2021	Introduction to Environmental Science I and Introduction to Environmental Science I Laboratory	
ES 2023 & ES 2031	Introduction to Environmental Science II and Introduction to Environmental Science II Laboratory	
ES 2113	Fundamentals of Geographic Information Systems (GIS)	
ES 3033 & ES 3042	Environmental Ecology and Environmental Ecology Laboratory	
ES 3123 & ES 3121	Introduction to Soils and Introduction to Soils Laboratory	
ES 3143 & ES 3141	Watershed Processes and Watershed Processes Laboratory	
ES 3203	Environmental Law	
ES 4103	Global Change	
ES 4203	Environmental Assessment	
ES 4212	Senior Seminar	
ES 4253	Sources, Fate, and Transport of Chemicals in the Environment	

### B. Required support courses (15 hours of which 6 are in the core) 15

Must be completed with a grade of "C-" or better		
CHE 1083	Introduction to the Molecular Structure of Matter	
CHE 1093	Introduction to Molecular Transformations	
COM 2113	Public Speaking	
ENG 2413	Technical Writing	
MAT 1093	Precalculus	

### C. Area of Study courses 21

Upper-division environmental science courses completed with a grade of "C-" or better

Twenty-one (21) semester credit hours of additional environmental science courses are required of which 15 hours must be upper-division. While the degree is a general degree in environmental science, four areas of study have been identified within the B.S. degree program for students interested in conservation and restoration ecology, environmental management, natural resources and wildlife management, or aquatic sciences. Depending on their area of interest, students may select courses from the following areas of study:

#### Conservation and Restoration Ecology

Required Courses:

ES 4213	Conservation Biology
ES 4233	Restoration Ecology

Select five courses from the following:

ES 3053	Environmental Remediation
ES 3073	Environmental Rhetoric and Technical Communication
ES 3103	Environmental Microbiology
ES 3113	Ichthyology
ES 3133	Oceanography
ES 3153	Environmental Chemistry
ES 3163	Ornithology
ES 3173	Mammalogy
ES 3183	Entomology
ES 3193	Herpetology
ES 3213	Biology of Flowering Plants
ES 3223	Woody Plants
ES 3233	Survey of Insects
ES 3253	R Coding in Environmental Science and Ecology
ES 3303	Sustainable Development
ES 3953	Topics in Environmental Science
ES 4023	Aquatic Ecology
ES 4113	Field Biology
ES 4123	Desert Biology
ES 4133	Natural Resource Policy and Administration
ES 4163	Renewable Energy
ES 4183	Environmental Toxicology
ES 4243	Wildlife Management
ES 4263	River Ecosystems
ES 4273	Fish Ecology
ES 4283	Plant-Soil-Microbe Interactions
ES 4293	Human Dimensions of Wildlife Management
ES 4303	Principles of Wildlife Management
ES 4503	Introduction to Environmental Risk Assessment
ES 4513	Advanced Environmental Risk Assessment
ES 4913	Independent Study
ES 4953	Special Studies in Environmental Science
ES 4963	Internship

#### Environmental Management

Required Courses:

ES 3053	Environmental Remediation
ES 3103	Environmental Microbiology
ES 4183	Environmental Toxicology
ES 4503	Introduction to Environmental Risk Assessment
ES 4513	Advanced Environmental Risk Assessment

Select two courses from the following:

ES 3073	Environmental Rhetoric and Technical Communication
ES 3113	Ichthyology
ES 3133	Oceanography
ES 3153	Environmental Chemistry
ES 3253	R Coding in Environmental Science and Ecology
ES 3303	Sustainable Development
ES 3953	Topics in Environmental Science
ES 4023	Aquatic Ecology
ES 4153	Introduction to Sustainability
ES 4163	Renewable Energy
ES 4173	Waste Water Treatment
ES 4243	Wildlife Management
ES 4263	River Ecosystems
ES 4283	Plant-Soil-Microbe Interactions
ES 4913	Independent Study
ES 4953	Special Studies in Environmental Science
ES 4963	Internship

#### Natural Resources and Wildlife Management

Required courses:

ES 4133	Natural Resource Policy and Administration
ES 4243	Wildlife Management

Select five courses from the following:

ES 3053	Environmental Remediation
ES 3073	Environmental Rhetoric and Technical Communication
ES 3103	Environmental Microbiology
ES 3113	Ichthyology
ES 3133	Oceanography
ES 3153	Environmental Chemistry
ES 3163	Ornithology
ES 3173	Mammalogy
ES 3183	Entomology
ES 3193	Herpetology
ES 3213	Biology of Flowering Plants
ES 3223	Woody Plants
ES 3233	Survey of Insects
ES 3253	R Coding in Environmental Science and Ecology
ES 3303	Sustainable Development
ES 3953	Topics in Environmental Science
ES 4023	Aquatic Ecology
ES 4113	Field Biology
ES 4123	Desert Biology

ES 4153	Introduction to Sustainability
ES 4163	Renewable Energy
ES 4173	Waste Water Treatment
ES 4183	Environmental Toxicology
ES 4213	Conservation Biology
ES 4233	Restoration Ecology
ES 4263	River Ecosystems
ES 4273	Fish Ecology
ES 4283	Plant-Soil-Microbe Interactions
ES 4293	Human Dimensions of Wildlife Management
ES 4303	Principles of Wildlife Management
ES 4913	Independent Study
ES 4953	Special Studies in Environmental Science
ES 4963	Internship

**Aquatic Sciences**

Required Courses:

ES 3113	Ichthyology
ES 4023	Aquatic Ecology
ES 4273	Fish Ecology

Select four courses from the following:

ES 3053	Environmental Remediation
ES 3073	Environmental Rhetoric and Technical Communication
ES 3103	Environmental Microbiology
ES 3133	Oceanography
ES 3153	Environmental Chemistry
ES 3163	Ornithology
ES 3173	Mammalogy
ES 3183	Entomology
ES 3193	Herpetology
ES 3213	Biology of Flowering Plants
ES 3223	Woody Plants
ES 3233	Survey of Insects
ES 3253	R Coding in Environmental Science and Ecology
ES 3303	Sustainable Development
ES 3953	Topics in Environmental Science
ES 4113	Field Biology
ES 4123	Desert Biology
ES 4133	Natural Resource Policy and Administration
ES 4153	Introduction to Sustainability
ES 4163	Renewable Energy
ES 4183	Environmental Toxicology
ES 4243	Wildlife Management
ES 4263	River Ecosystems
ES 4283	Plant-Soil-Microbe Interactions
ES 4293	Human Dimensions of Wildlife Management
ES 4303	Principles of Wildlife Management
ES 4503	Introduction to Environmental Risk Assessment

ES 4513	Advanced Environmental Risk Assessment
ES 4913	Independent Study
ES 4953	Special Studies in Environmental Science
ES 4963	Internship

**Total Credit Hours** **90**

**Course Sequence Guide for B.S. Degree in Environmental Science**

This course sequence guide is designed to assist students in completing their UTSA B.S. Degree in Environmental Science. *This is merely a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans.* Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. Students may choose to take courses during Summer terms to reduce course loads during long semesters.

**B.S. in Environmental Science – Recommended Four-Year Academic Plan**

**First Year**

<b>Fall</b>		<b>Credit Hours</b>
AIS 1203	Academic Inquiry and Scholarship (core)	3
ES 1123	Environmental Zoology (core and major)	3
ES 1121	Environmental Zoology Laboratory	1
MAT 1093	Precalculus (core)	3
WRC 1013	Freshman Composition I (core)	3
Creative Arts (core)		3
<b>Credit Hours</b>		<b>16</b>

**Spring**

COM 2113	Public Speaking (core)	3
ES 1113	Environmental Botany (core)	3
ES 1111	Environmental Botany Laboratory	1
ES 1314	Environmental Statistics	4
WRC 1023	Freshman Composition II (core)	3
<b>Credit Hours</b>		<b>14</b>

**Second Year**

**Fall**

ES 2013	Introduction to Environmental Science I	3
ES 2021	Introduction to Environmental Science I Laboratory	1
ES 2113	Fundamentals of Geographic Information Systems (GIS)	3
CHE 1083	Introduction to the Molecular Structure of Matter	3
POL 1013	Introduction to American Politics (core)	3
American History (core)		3
<b>Credit Hours</b>		<b>16</b>

**Spring**

ES 2023	Introduction to Environmental Science II	3
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ES 2031	Introduction to Environmental Science II Laboratory	1
ES 1213	Environmental Geology	3
ES 1211	Environmental Geology Laboratory	1
CHE 1093	Introduction to Molecular Transformations	3
ENG 2413	Technical Writing	3
<b>Credit Hours</b>		<b>14</b>

**Third Year****Fall**

ES 3123	Introduction to Soils	3
ES 3121	Introduction to Soils Laboratory	1
ES 3033	Environmental Ecology	3
ES 3042	Environmental Ecology Laboratory	2
POL 1133	Texas Politics and Society (core)	3
ES Area of Study Required		3
<b>Credit Hours</b>		<b>15</b>

**Spring**

ES 3143	Watershed Processes	3
ES 3141	Watershed Processes Laboratory	1
ES 4253	Sources, Fate, and Transport of Chemicals in the Environment	3
ES Area of Study Required		3
ES Area of Study Elective		3
American History (core)		3
<b>Credit Hours</b>		<b>16</b>

**Fourth Year****Fall**

ES 4103	Global Change (major)	3
ES 3203	Environmental Law (major)	3
ES Area of Study Elective (major)		3
ES Area of Study Elective (major)		3
Language, Philosophy & Culture (core)		3
<b>Credit Hours</b>		<b>15</b>

**Spring**

ES 4203	Environmental Assessment	3
ES 4212	Senior Seminar	2
ES Area of Study Elective		3
ES Area of Study Elective		3
Social and Behavioral Science (core)		3
<b>Credit Hours</b>		<b>14</b>
<b>Total Credit Hours</b>		<b>120</b>

Note: Some courses are only offered once a year; Fall or Spring. Check with the Department of Integrative Biology for scheduling of courses.

## Bachelor of Arts Degree in Environmental Studies

The Bachelor of Arts (B.A.) degree in Environmental Studies is designed to provide students with a multidisciplinary educational approach regarding environmental issues and foster system-thinking skills. The degree reinforces the crucial role of interdisciplinary approaches in environmental problem solving by emphasizing the sociocultural,

historical, ethical, spiritual, economic, and political dimensions of complex environmental issues. Solving these problems requires an integration of disciplines to provide the understanding needed to address complex environmental issues.

The field includes study in basic principles of ecology and environmental science, as well as associated subjects such as ethics, geography, policy, politics, law, economics, philosophy, environmental sociology, environmental justice, urban planning, pollution control, and natural resource management.

Some of the careers a B.A. degree in Environmental Studies will prepare students for are environmental consultant, environmental educator, environmental lobbyist, environmental planner, environmental attorney, natural resource specialist, outdoor education teacher, park naturalist, park ranger, resource economist, policy analyst, public relations specialist, sustainability specialist, and urban and regional planner.

The minimum number of semester credit hours required for the B.A. degree in Environmental Studies, including the Core Curriculum requirements, is 120.

Thirty-nine of the total semester credit hours required for the degree must be at the upper-division level.

All major and support work courses and the required prerequisites must be completed with a grade of "C-" or better.

### Program Outcomes

Graduates of the B.A. Degree in Environmental Studies program will be able to:

- Explain foundational concepts in the natural sciences, social sciences, and humanities as applied to environmental issues, including human-environment interactions, monitoring the health of environmental systems, environmental policy & law, urbanization and impacts of built environments, sustainability, and socio-cultural influences on human-environment relationships.
- Apply systems thinking and multidisciplinary methodologies to address environmental problems.
- Apply the process of scientific inquiry.
- Demonstrate critical thinking skills in relation to environmental issues.
- Use appropriate field and/or laboratory methods to collect quality data.
- Use appropriate quantitative and qualitative methods to evaluate environmental data.
- Demonstrate ability to work effectively in a team with others from diverse disciplines and backgrounds.
- Effectively communicate scientific information, and the relationship between science and society, to a diverse audience through oral, written, and visual means.

### Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.A. Degree in Environmental Studies must fulfill University Core Curriculum requirements in the same manner as other students. If courses are taken to satisfy both degree requirements and Core Curriculum requirements, then students may need to take additional courses to meet the minimum number of semester credit hours required for this degree.

Core Curriculum Component Area Requirements (<http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degerequirements/corecurriculumcomponentarearequirements/>)

First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
<b>Total Credit Hours</b>	<b>42</b>

**Degree Requirements**

Code	Title	Credit Hours
<b>A. Required courses (72 hours of which 12 are in the core)</b>		<b>72</b>
Must be completed with a grade of "C-" or better		
ANT 2053	Introduction to Cultural Anthropology	
CHE 1083	Introduction to the Molecular Structure of Matter	
ECO 2003	Economic Principles and Issues	
ENG 2413	Technical Writing	
ES 1003	Survey Topics in Environmental Studies	
ES 1113	Environmental Botany	
ES 1123	Environmental Zoology	
ES 1213	Environmental Geology	
ES 1314	Environmental Statistics	
ES 2013 & ES 2021	Introduction to Environmental Science I and Introduction to Environmental Science I Laboratory	
ES 2023 & ES 2031	Introduction to Environmental Science II and Introduction to Environmental Science II Laboratory	
ES 2113	Fundamentals of Geographic Information Systems (GIS)	
COM 2113	Public Speaking	
ENG 3383	Writing in Public and Professional Contexts	
ES 3203	Environmental Law	
ES 4133	Natural Resource Policy and Administration	
ES 4153	Introduction to Sustainability	
ES 4163	Renewable Energy	
ES 4203	Environmental Assessment	
GES 3753	Climate Change	
MS 4333	Project Management	
PAD 3043	Public and Nonprofit Financial Management	
PAD 3163	Quantitative Analysis for Public Administration and Policy	
<b>B. Choose four (4) of the following courses</b>		<b>12</b>

Twelve (12) semester credit hours of additional elective hours from the following list:

ANT 3223	Anthropology and the Environment	
ANT 3333	Human Adaptability	
ANT 3873	Food, Culture, and Society	
COM 3023	Foundations of Communication	
COM 3243	Persuasion	
ES 3033	Environmental Ecology	
ES 3123	Introduction to Soils	
ES 3143	Watershed Processes	
ES 3163	Ornithology	
ES 3173	Mammalogy	
ES 3183	Entomology	
ES 3193	Herpetology	
ES 3213	Biology of Flowering Plants	
ES 3223	Woody Plants	
ES 4213	Conservation Biology	
GES 3613	Conservation of Resources	
GES 3713	Weather and Climate	
GES 3723	Physiography	
GES 3743	Biogeography	
HIS 4223	Environmental History of the United States	
HTH 4543	Environmental Health and Safety	
PAD 3003	Fundraising in Nonprofit Agencies	
PAD 3023	Introduction to Urban Management and Policy	
PAD 3033	Introduction to Nonprofit Agencies	
PAD 3053	Urban Economic Development	
PAD 3113	Managing Nonprofit Organizations	
SOC 3223	Population Dynamics and Demographic Techniques	
<b>C. Choose two of the following courses</b>		<b>6</b>
ES 4953	Special Studies in Environmental Science	
ES 4963	Internship	
ES 4113	Field Biology	
ES 4123	Desert Biology	

**Total Credit Hours** **90**

**Course Sequence Guide for B.A. Degree in Environmental Studies**

This course sequence guide is designed to assist students in completing their UTSA B.A. Degree in Environmental Studies. *This is merely a guide and students must satisfy other requirements of this catalog and meet with their academic advisor for individualized degree plans.* Progress within this guide depends upon such factors as course availability, individual student academic preparation, student time management, work obligations, and individual financial considerations. Students may choose to take courses during Summer terms to reduce course loads during long semesters.

**B.A. in Environmental Studies – Recommended Four-Year Academic Plan**

First Year		Credit Hours
<b>Fall</b>		
AIS 1203	Academic Inquiry and Scholarship (core)	3

ES 1003	Survey Topics in Environmental Studies	3
ES 1123	Environmental Zoology (core and major)	3
WRC 1013	Freshman Composition I (core)	3
Mathematics (core)		3
<b>Credit Hours</b>		<b>15</b>
<b>Spring</b>		
CHE 1083	Introduction to the Molecular Structure of Matter	3
ES 1113	Environmental Botany (core and major)	3
POL 1013	Introduction to American Politics (core)	3
WRC 1023	Freshman Composition II (core)	3
Language, Philosophy, & Culture (core)		3
<b>Credit Hours</b>		<b>15</b>
<b>Second Year</b>		
<b>Fall</b>		
ENG 2413	Technical Writing (core and major)	3
ES 1314	Environmental Statistics	4
ES 2013	Introduction to Environmental Science I	3
ES 2021	Introduction to Environmental Science I Laboratory	1
American History (core)		3
<b>Credit Hours</b>		<b>14</b>
<b>Spring</b>		
COM 2113	Public Speaking (required and core)	3
ECO 2003	Economic Principles and Issues	3
ES 1213	Environmental Geology	3
ES 2023	Introduction to Environmental Science II	3
ES 2031	Introduction to Environmental Science II Laboratory	1
POL 1133	Texas Politics and Society (core)	3
<b>Credit Hours</b>		<b>16</b>
<b>Third Year</b>		
<b>Fall</b>		
ANT 2053	Introduction to Cultural Anthropology (core)	3
ENG 3383	Writing in Public and Professional Contexts	3
ES 3203	Environmental Law	3
American History (core)		3
Creative Arts (core)		3
<b>Credit Hours</b>		<b>15</b>
<b>Spring</b>		
ES 4163	Renewable Energy	3
MS 4333	Project Management	3
PAD 3043	Public and Nonprofit Financial Management	3
Elective		3

Elective		3
<b>Credit Hours</b>		<b>15</b>
<b>Fourth Year</b>		
<b>Fall</b>		
ES 2113	Fundamentals of Geographic Information Systems (GIS)	3
PAD 3163	Quantitative Analysis for Public Administration and Policy	3
GES 3753	Climate Change	3
Elective		3
Internship, Independent Study, Field Course		3
<b>Credit Hours</b>		<b>15</b>
<b>Spring</b>		
ES 4133	Natural Resource Policy and Administration	3
ES 4153	Introduction to Sustainability	3
ES 4203	Environmental Assessment	3
Elective		3
Internship, Independent Study, Field Course		3
<b>Credit Hours</b>		<b>15</b>
<b>Total Credit Hours</b>		<b>120</b>

Note: Some courses are only offered once a year; Fall or Spring. Check with the Department of Integrative Biology for scheduling of courses.

## Bachelor of Science Degree in Multidisciplinary Science with Teacher Certification in Grades 7-12

The Bachelor of Science (B.S.) Degree in Multidisciplinary Science (MDS.) is designed for future secondary science teachers and gives students broad training across the sciences. The MDS degree offers a composite science certification track through the College of Education and Human Development (COEHD) and in conjunction with UTeachSA, which is designed to prepare students for a career in teaching secondary school science. Students seeking teacher certification should contact the Interdisciplinary Education Advising and Certification Center as early in their educational program as possible, but no later than their fourth semester of study, for information about certificate requirements and admission procedures. Undergraduates seeking elementary teacher certification must complete the Interdisciplinary Studies degree.

Some of the careers a B.S. degree in Multidisciplinary Science will prepare students for are teaching various science courses in grades 7-12, including biology, chemistry, physics, integrated physics and chemistry, astronomy, Earth and space science, environmental systems, aquatic science, anatomy and physiology, medical microbiology, pathophysiology, and scientific research and design.

The minimum number of semester credit hours required for this degree, including the Core Curriculum requirements, is 120 hours.

Thirty-nine of the total semester credit hours for the degree must be at the upper-division level. All major and support work must be completed with a grade of "C-" or better.

All candidates seeking this degree must fulfill the Core Curriculum requirements and the degree requirements, which are listed below.

## Program Outcomes

Graduates of the B.S. Degree in Multidisciplinary Sciences program will be able to:

- Explain foundational concepts in the sciences, specifically:
  - physics and astronomy
  - chemistry
  - biology including cell structure, biological processes, genetics, and evolution
  - environmental science including biodiversity
  - geology
- Develop skills in teaching, learning, and assessment.
- Apply the process of scientific inquiry.
- Demonstrate critical thinking skills in relation to scientific issues.
- Use appropriate field and/or laboratory methods to collect quality data.
- Use appropriate quantitative and qualitative methods to evaluate scientific data.
- Demonstrate ability to work effectively in a team with others from diverse disciplines and backgrounds.
- Effectively communicate scientific information, and the relationship between science and society, to a diverse audience through oral, written, and visual means.

## Criminal Background Check

Teacher preparation programs at UTSA requires fieldwork in public schools. This requires that a student be able to pass a criminal background check conducted by the school districts. It is the responsibility of the student to determine if their criminal history background will present a problem before applying for admission to the teacher preparation program. Students with a problematic criminal history will encounter difficulty in completing any fieldwork requirements and may not be able to complete the program.

## Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. Degree in Multidisciplinary Science must fulfill University Core Curriculum requirements in the same manner as other students. If courses are taken to satisfy both degree requirements and Core Curriculum requirements, then students may need to take additional courses to meet the minimum number of semester credit hours required for this degree.

Core Curriculum Component Area Requirements (<http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/>)

First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
<b>Total Credit Hours</b>	<b>42</b>

## Gateway Course

Students pursuing the B.S. Degree in Multidisciplinary Science must complete the following Gateway Course with a grade of “C-” or better in no more than two attempts. A student who is unable to complete the course within two attempts, including dropping a course with a grade of “W” or taking an equivalent course at another institution, will be required to change his or her major.

Code	Title	Credit Hours
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors	

## Degree Requirements

Code	Title	Credit Hours
<b>A. Required science and mathematics courses</b>		
AST 1033	Exploration of the Solar System	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors	4
BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors	4
BIO 2313	Genetics	3
BIO 3413	General Physiology	3
CHE 1103 & CHE 1121	General Chemistry I and General Chemistry I Laboratory	4
CHE 1113 & CHE 1131	General Chemistry II and General Chemistry II Laboratory	4
ES 2013 & ES 2021	Introduction to Environmental Science I and Introduction to Environmental Science I Laboratory	4
ES 2023 & ES 2031	Introduction to Environmental Science II and Introduction to Environmental Science II Laboratory	4
ES 3033	Environmental Ecology	3
ES 3133	Oceanography	3
GEO 1103 & GEO 1111	Physical Geology and Physical Geology Laboratory	4
MAT 1193 or STA 1053	Calculus for the Biosciences or Basic Statistics	3
ES 4023	Aquatic Ecology	3
	Select one of the following options:	8
Option 1		
PHY 1603 & PHY 1611	Algebra-based Physics I and Algebra-based Physics I Laboratory	
PHY 1623 & PHY 1631	Algebra-based Physics II and Algebra-based Physics II Laboratory	
Option 2		
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory <sup>1</sup>	
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory <sup>1</sup>	



**Education Courses**

30 semester credit hours of UTeachSA and education courses		
ESL 3083	Second Language Teaching and Learning for Grades 7-12	3
LTED 3773	Reading and Writing Across the Disciplines-Grades 7-12	3
SPE 3603	Introduction to Special Education	3
UTE 1111	Introduction to STEM Teaching Step 1	1
UTE 1122	Introduction to STEM Teaching Step 2	2
UTE 3023	Perspectives on Science and Mathematics	3
UTE 3203	Knowing and Learning in Mathematics and Science	3
UTE 3213	Classroom Interactions	3
UTE 4203	Project-Based Instruction	3
UTE 4646	Clinical Teaching	6
<b>Total Credit Hours</b>		<b>87</b>

**Certification Requirements (Composite Science Emphasis)**

Students seeking a B.S. Degree in Multidisciplinary Sciences (MDS) as preparation for a graduate degree in science should follow as closely as possible the degree requirements of their chosen science as those courses are most likely to be required by graduate schools in that field. It is possible through careful planning to achieve a double major in M.D.S. and another science. All MDS students should create a four-year plan through an undergraduate academic advisor as early as possible in their course of study, and continue to check in on a course-by-course basis should those plans change.

**B.S. in Multidisciplinary Science with Grades 7-12 Teaching Certification – Recommended Four-Year Academic Plan****First Year**

Fall		Credit Hours
AIS 1203	Academic Inquiry and Scholarship (core)	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors (core and major)	4
WRC 1013	Freshman Composition I (core)	3
UTE 1111	Introduction to STEM Teaching Step 1	1
American History (core)		3
<b>Credit Hours</b>		<b>14</b>

**Spring**

BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors (core and major)	4
MAT 1193 or STA 1053	Calculus for the Biosciences (core and major) or Basic Statistics	3
WRC 1023	Freshman Composition II (core)	3
UTE 1122	Introduction to STEM Teaching Step 2	2
American History (core)		3
<b>Credit Hours</b>		<b>15</b>

**Summer**

CS 1173	Data Analysis and Visualization (core)	3
PSY 1013	Introduction to Psychology (core)	3
Government-Political Science (core)		3
Language, Philosophy & Culture (core)		3

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<b>Credit Hours</b>	<b>12</b>
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**Second Year****Fall**

CHE 1103 & CHE 1121	General Chemistry I and General Chemistry I Laboratory	4
ES 2013 & ES 2021	Introduction to Environmental Science I and Introduction to Environmental Science I Laboratory	4
UTE 3203	Knowing and Learning in Mathematics and Science	3
Creative Arts (core)		3

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<b>Credit Hours</b>	<b>14</b>
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**Spring**

CHE 1113 & CHE 1131	General Chemistry II and General Chemistry II Laboratory	4
GEO 1103 & GEO 1111	Physical Geology and Physical Geology Laboratory	4
UTE 3213	Classroom Interactions	3
Government-Political Science (core)		3

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<b>Credit Hours</b>	<b>14</b>
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**Third Year****Fall**

BIO 2313	Genetics	3
ES 2023 & ES 2021	Introduction to Environmental Science II and Introduction to Environmental Science I Laboratory	4
UTE 3023	Perspectives on Science and Mathematics	3
Select one of the following:		4
PHY 1603 & PHY 1611	Algebra-based Physics I and Algebra-based Physics I Laboratory	

or

PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	
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<b>Credit Hours</b>	<b>14</b>
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**Spring**

ES 3033	Environmental Ecology	3
ES 3133	Oceanography	3
SPE 3603	Introduction to Special Education	3
UTE 4203	Project-Based Instruction	3

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Select one of the following:		4
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PHY 1623 & PHY 1631	Algebra-based Physics II and Algebra-based Physics II Laboratory	
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or		
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	
<b>Credit Hours</b>		<b>16</b>
<b>Fourth Year</b>		
<b>Fall</b>		
AST 1033	Exploration of the Solar System	3
BIO 3413	General Physiology	3
ES 4023	Aquatic Ecology	3
ESL 3083	Second Language Teaching and Learning for Grades 7-12	3
LTED 3773	Reading and Writing Across the Disciplines-Grades 7-12	3
<b>Credit Hours</b>		<b>15</b>
<b>Spring</b>		
CI 4646	Clinical Teaching: Grades 7-12	6
<b>Credit Hours</b>		<b>6</b>
<b>Total Credit Hours</b>		<b>120</b>

Note: Some courses are only offered once a year. Fall or Spring. Check with the Department of Environmental Science and Ecology for scheduling of courses.

- Minor in Biology (p. 18)
- Minor in Environmental Science (p. 18)

## Minor in Biology

The Minor in Biology is open to all majors in the University. To declare a Minor in Biology or obtain advice, students should consult with their academic advisor. All students pursuing the minor must complete a minimum of 20 semester credit hours of Biology courses. It should be noted that students seeking a minor must also complete applicable support coursework in chemistry, computer science, physics, mathematics and statistics, as needed to fulfill the normal prerequisites for any course listed below. All Biology courses and their prerequisites must be completed with a grade of "C-" or better, and students must achieve a grade point average of at least 2.0 on all work used to satisfy the requirements of the minor.

Code	Title	Credit Hours
<b>A. Required courses</b>		
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors	4
BIO 1223 & BIO 1221	Biosciences II for Science Majors and Biosciences II Laboratory for Science Majors	4
BIO 2313	Genetics	3
<b>B. 3000- or 4000-level organized biology courses</b>		
Three upper-division biology lecture courses. Excludes laboratory, independent study, research and seminar courses. Substitutions are not allowed without approval of the Biology department.		9
<b>Total Credit Hours</b>		<b>20</b>

## Minor in Environmental Science

The Minor in Environmental Science is open to all majors in the University. To declare a Minor in Environmental Science or obtain advice, students should consult with their academic advisor. All students pursuing the Minor in Environmental Science must complete 22 semester credit hours of Environmental Science courses including a minimum of 6 hours of upper-division courses. All coursework must be completed with a grade of "C-" or better.

Code	Title	Credit Hours
<b>A. 16 semester credit hours of required courses:</b>		
ES 2013	Introduction to Environmental Science I	16
ES 2021	Introduction to Environmental Science I Laboratory	
ES 2023	Introduction to Environmental Science II	
ES 2031	Introduction to Environmental Science II Laboratory	
ES 3033	Environmental Ecology	
ES 3042	Environmental Ecology Laboratory	
ES 3203	Environmental Law	
<b>B. 6 additional semester credit hours from the following courses:</b>		
ES 3123	Introduction to Soils	6
ES 3143	Watershed Processes	
ES 4133	Natural Resource Policy and Administration	
ES 4163	Renewable Energy	
ES 4203	Environmental Assessment	
ES 4213	Conservation Biology	
ES 4233	Restoration Ecology	
<b>Total Credit Hours</b>		<b>22</b>

## Biology (BIO) Courses

### BIO 1033. Drugs and Society. (3-0) 3 Credit Hours. (TCCN = PHED 1346)

An examination of licit and illicit drugs and their biosocial effects. Topics include pharmacology of alcohol, stimulants, hallucinogens, addiction, and abuse. May be applied toward the Core Curriculum requirement in Social and Behavioral Sciences. Same as NDRB 1033. Credit cannot be earned for both NDRB 1033 and BIO 1033. Generally offered: Fall, Spring. Course fees: LRC1 \$12; LRS1 \$46.20; DL01 \$75; STSI \$21.60.

### BIO 1053. Introductory Microbiology. (3-0) 3 Credit Hours. (TCCN = BIOL 2320)

Prerequisite: BIO 1203 (formerly BIO 1404) or BIO 1233. A general study of microorganisms, their characteristics, isolation, growth, and importance in nature, industry, public health, and human disease. (Formerly AHS 1053. Same as MMI 1053. Credit can only be earned for one of the following courses: BIO 1053, AHS 1053, or MMI 1053. BIO 1053 cannot substitute for BIO 3713.) Generally offered: Fall, Spring. Course Fees: LRS1 \$46.20; STSI \$21.60.

**BIO 1061. Introductory Microbiology Laboratory. (0-3) 1 Credit Hour. (TCCN = BIOL 2120)**

Prerequisites: BIO 1233 or BIO 1203 (formerly BIO 1404), and completion of or concurrent enrollment in BIO 1053. Course provides basic microbiology lab skills and procedures, with emphasis on the growth, identification, and control of microbes of concern to health-care professionals. Immunodeficient and pregnant students must contact the Coordinator, Microbiology Teaching Labs, for additional instructions prior to the class start date. (Formerly AHS 1061 in previous catalogs and same as MMI 1061. Credit cannot be earned for more than one of BIO 1061, AHS 1061, or MMI 1061. BIO 1061 cannot substitute for BIO 3722.) Generally offered: Fall, Spring, Summer. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20; DL01 \$25.

**BIO 1173. Introduction to Computational Biology. (3-0) 3 Credit Hours.**

Prerequisite: MAT 1193. Introduction to computation for biologists, using a modern, open-source programming language such as Python or R. Programming concepts, including data types, functions, loops, and logic are explored within a context of realistic biological problems and data sets. Basic data visualization techniques are also explored. Generally offered: Fall, Spring, Summer. IUS1 \$15; LRS1 \$46.20; STSI \$21.60.

**BIO 1201. Biosciences I Laboratory for Science Majors. (0-3) 1 Credit Hour. (TCCN = BIOL 1106)**

Prerequisite: Completion of or concurrent enrollment in one of the following: STA 1053, MAT 1023, MAT 1073, or higher. Corequisite: BIO 1203 for biology majors. This laboratory-based course accompanies BIO 1203, Biosciences I for Science Majors. Laboratory activities will reinforce the fundamental principles of living organisms, including physical and chemical properties of life, organization, function, evolutionary adaptation, and classification. Study and examination of the concepts of cytology, reproduction, genetics, and scientific reasoning are included. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20.

**BIO 1203. Biosciences I for Science Majors. (3-0) 3 Credit Hours. (TCCN = BIOL 1306)**

Prerequisite: Completion of or concurrent enrollment in one of the following: STA 1053, MAT 1023, MAT 1073, or higher. Corequisite: BIO 1201 is required for biology majors. This is the first course in a two-part introduction to the science of biology for students majoring in biology or interested in pre-health professions. Topics include biochemistry, cell biology, genetics and molecular biology. May be applied toward the Core Curriculum requirement in Life and Physical Sciences. (Formerly BIO 1113 and BIO 1404 in previous catalogs. Credit can only be earned for one of the following courses: BIO 1203, BIO 1404, or BIO 1113). Generally offered: Fall, Spring, Summer. Course Fees: LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

**BIO 1221. Biosciences II Laboratory for Science Majors. (0-3) 1 Credit Hour. (TCCN = BIOL 1107)**

Prerequisite: BIO 1203 and BIO 1201 (or equivalent). Corequisite: BIO 1223 is required for biology majors. This laboratory-based course accompanies BIO 1223, Biosciences II for Science Majors. Laboratory activities will reinforce study of the diversity and classification of life, including animals, plants, protists, fungi, and prokaryotes. Special emphasis will be given to anatomy, physiology, ecology, and evolution of plants and animals. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20.

**BIO 1223. Biosciences II for Science Majors. (3-0) 3 Credit Hours. (TCCN = BIOL 1307)**

Prerequisite: BIO 1203. Concurrent enrollment in BIO 1221 is required for biology majors. This is the second course in a two-part introduction to the science of biology for students majoring in biology or interested in pre-health professions. Topics include evolutionary biology, biotic diversity, plant structure and function, and ecology. May be applied toward the Core Curriculum requirement in Life and Physical Sciences. (Course formerly listed as BIO 1143, BIO 1413, and BIO 1414 in previous catalogs. Credit cannot be earned for more than one of the following: BIO 1143, BIO 1223, BIO 1413, BIO 1414, or ES 2013.) Generally offered: Fall, Spring, Summer. Course Fees: LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

**BIO 1233. Contemporary Biology I. (3-0) 3 Credit Hours. (TCCN = BIOL 1308)**

This is the first course in a two-part introduction to the science of biology for non-majors. This course focuses on the chemical basis of life, principles of inheritance, principles of evolution and biodiversity. May be applied toward the Core Curriculum requirement in Life and Physical Sciences. May not be applied to a B.S. degree in Biology or B.S. degree in Microbiology and Immunology. Generally offered: Fall, Spring. Course Fees: LRC1 \$12; LRS1 \$46.20; STSI \$21.60; DL01 \$75.

**BIO 1243. Contemporary Biology II. (3-0) 3 Credit Hours. (TCCN = BIOL 1309)**

This is the second course in a two-part introduction to the science of biology for non-majors. This course focuses on evolution, animal and plant physiology, and ecology. May be applied toward the Core Curriculum requirement in Life and Physical Sciences. May not be applied to a B.S. degree in Biology or the B.S. degree in Microbiology and Immunology. Generally offered: Fall, Spring, Summer. Course Fees: DL01 \$75; LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

**BIO 2003. Biology of Human Reproduction. (3-0) 3 Credit Hours.**

An in-depth look at human reproductive anatomy, physiology, and behavior. Topics to be considered include anatomy, sex differentiation, neuroendocrine physiology, conception and development, birth control, and sexually transmitted diseases. (Formerly BIO 1023 in previous catalogs. Credit cannot be earned for both BIO 2003 and BIO 1023.) Generally offered: Spring. Course Fees: LRS1 \$46.20; STSI \$21.60.

**BIO 2043. Nutrition. (3-0) 3 Credit Hours. (TCCN = BIOL 1322)**

Prerequisite: BIO 1233 or BIO 1203 (formerly BIO 1404). In-depth study of nutrient classes in foods: their ingestion, digestion, absorption and utilization by the human body. Clinical consequences of nutrient deficiency or excess, and Medical Nutrition Therapy to complement management of disease. (Formerly AHS 2043 in previous catalogs. Same as NDT 2043. Credit cannot be earned for more than one of the following courses: AHS 2043, BIO 2043, or NDT 2043.) Generally offered: Fall, Spring, Summer. Course Fees: LRS1 \$46.20; STSI \$21.60; DL01 \$75.

**BIO 2051. Human Anatomy and Physiology Laboratory I. (0-3) 1 Credit Hour. (TCCN = BIOL 2101)**

Prerequisites: BIO 1203 or BIO 1233; previous or concurrent enrollment in BIO 2053 is required. This laboratory supplements the BIO 2053 lecture. Designed for pre-nursing and allied health students. Not recommended for pre-medical and pre-dental students. It is the first of a two-course laboratory sequence that uses both dissections of representative organisms and laboratory experimentation to study human anatomical systems and physiological processes. (Same as BIO 3642. Credit cannot be earned for both BIO 2051 and BIO 3642. BIO 2051 cannot substitute for BIO 3422.) Generally offered: Fall, Spring, Summer. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20; DL01 \$25.

**BIO 2053. Human Anatomy and Physiology I. (3-0) 3 Credit Hours. (TCCN = BIOL 2301)**

Prerequisite: BIO 1203 or BIO 1233; concurrent enrollment in BIO 2051 is required. Designed for pre-nursing and allied health students. Not recommended for pre-medical and pre-dental students. This is the first of a two-course sequence that provides an integrative study of the anatomy and physiology of the human body with an emphasis on the structure/function interrelationships between organ systems. Topics covered include cell and tissue biology, the integumentary, skeletal, muscular, and nervous systems. (Same as BIO 3643. Credit cannot be earned for both BIO 2053 and BIO 3643. BIO 2053 cannot substitute for BIO 3413.) Generally offered: Fall, Spring, Summer. Course Fees: LRS1 \$46.20; STSI \$21.60; DL01 \$75.

**BIO 2061. Human Anatomy and Physiology Laboratory II. (0-3) 1 Credit Hour. (TCCN = BIOL 2102)**

Prerequisites: BIO 2051; previous or concurrent enrollment in BIO 2063 is required. Designed for pre-nursing and allied health students. Not recommended for pre-medical and pre-dental students. This laboratory supplements the BIO 2063 lecture. It is the second of a two-course laboratory sequence that uses both dissections of representative organisms and laboratory experimentation to study human anatomical systems and physiological processes. (Same as BIO 3652. Credit cannot be earned for both BIO 2061 and BIO 3652. BIO 2061 cannot substitute for BIO 3422.) Generally offered: Fall, Spring, Summer. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20; DL01 \$25.

**BIO 2063. Human Anatomy and Physiology II. (3-0) 3 Credit Hours. (TCCN = BIOL 2302)**

Prerequisite: BIO 2053; concurrent enrollment in BIO 2061 is required. Designed for pre-nursing and allied health students. Not recommended for pre-medical and pre-dental students. This is the second of a two-course sequence that provides an integrative study of the anatomy and physiology of the human body with an emphasis on the structure/function interrelationships between organ systems. Topics covered include the endocrine, digestive, respiratory, cardiovascular, lymphatic/immune, renal and reproductive systems. Human growth and development will also be covered. (Same as BIO 3653. Credit cannot be earned for both BIO 2063 and BIO 3653. BIO 2063 cannot substitute for BIO 3413.) Generally offered: Fall, Spring, Summer. Course Fees: LRS1 \$46.20; STSI \$21.60; DL01 \$75.

**BIO 2073. Sophomore Research Experience. (1-4) 3 Credit Hours.**

Prerequisite: BIO 1203, BIO 1201, BIO 1223, and BIO 1221 with a grade of at least a 'C-'. Restricted to students who have completed 30 or more hours. The organizing principles of biology (such as molecular and cellular functions, reproduction, development, homeostatic mechanisms, and organismal physiology and behavior) are used within a comparative and evolutionary framework to train students in modern laboratory techniques, bioinformatics, experimental design, and interpretation of results. Generally offered: Fall and Spring.

**BIO 2313. Genetics. (3-0) 3 Credit Hours. (TCCN = BIOL 2316)**

Prerequisites: BIO 1223 and completion or concurrent enrollment in one of the following: MAT 1093 (or higher) or STA 1053. Principles governing transmission of hereditary factors in plants and animals, with emphasis on molecular, biochemical, and population genetics. Generally offered: Fall, Spring, Summer. Course Fees: LRS1 \$46.20; STSI \$21.60; DL01 \$75.

**BIO 2362. Molecular Genetics Laboratory. (1-4) 2 Credit Hours.**

Prerequisites: BIO 1223, CHE 1103, and completion or concurrent enrollment in MAT 1093 or higher. A study of techniques used to investigate the inheritance of genetic information at the molecular level. Students will gain an understanding of the structure, function and regulation of genes. Techniques will include; nucleic acid biochemistry, molecular cloning mutagenesis and bioinformatics. (Formerly BIO 2322. Credit cannot be earned for both BIO 2362 and BIO 2322.) Generally offered: Fall, Spring, Summer. Course Fees: L001 \$30; LRS1 \$30.80; STSI \$14.40; DL01 \$50.

**BIO 2953. Special Topics in Biology. (3-0) 3 Credit Hours.**

An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Topics may be repeated for credit when the topics vary, but not more than 6 semester credit hours will apply to a bachelor's degree, regardless of discipline. No more than 6 semester credit hours of BIO 2953, BIO 4951, or BIO 4953 can be applied to a Bachelor of Science degree in Biology or Microbiology and Immunology. Course Fees: LRS1 \$46.20; STSI \$21.60.

**BIO 2992. Medical Terminology. (2-0) 2 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. This course covers the language of medicine that will be used as a foundation for understanding upper-division undergraduate and graduate-level courses to follow. It will include pronunciation, definition, usage, and origins of medical terms. Medical terms presented will be used to identify signs, symptoms, diagnoses, and treatment options for selected pathologies. With these skills the student will be able to effectively interpret and communicate in a healthcare setting. Generally offered: Fall. Course Fees: LRS1 \$30.80; STSI \$14.40.

**BIO 3013. Introduction to Clinical Medicine and Pathology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, BIO 2313, and BIO 2992. Introduction to concepts of human disease, diagnosis, and underlying pathology. Same as MMI 3013. Credit cannot be earned for both BIO 3013 and MMI 3013. Generally offered: Fall. Differential Tuition: \$150.

**BIO 3043. UTeachSA Research Methods. (3-0) 3 Credit Hours.**

Prerequisite: This course is only open to students who are participating in the UTeachSA teacher preparation program. Students design and carry out independent inquiries, which they write up and present in the manner that is common in the scientific community. Inquiries incorporate mathematics and the various science disciplines to solve research problems. Only 6 semester credit hours of BIO 3043, BIO 4911-3, BIO 4923 and BIO 4993, in any combination, can be taken as BIO electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. (Same as UTE 3043. Credit cannot be earned for both BIO 3043 and UTE 3043.) Generally offered: Fall, Spring. Differential Tuition \$150.

**BIO 3053. Sophomore Research Experience. (1-4) 3 Credit Hours.**

Prerequisite: BIO 1203, BIO 1201, BIO 1223, and BIO 1221 with a grade of at least a 'C-'. Restricted to students who have completed 30 or more hours. The organizing principles of biology (such as molecular and cellular functions, reproduction, development, homeostatic mechanisms, and organismal physiology and behavior) are used within a comparative and evolutionary framework to train students in modern laboratory techniques, bioinformatics, experimental design, and interpretation of results. Generally offered: Spring. Differential Tuition: \$150.

**BIO 3073. Environmental Rhetoric and Technical Communication. (3-0) 3 Credit Hours.**

Prerequisite: ENG 2413. Restricted to students who have completed 60 or more hours. This course focuses on rhetoric, ecology, and technical/scientific communication in order to develop interdisciplinary, team-based, and applied research projects. This advanced professional writing and rhetoric course will examine ecological communications as an archetypal example of specialized technical communication. (Same as ES 3073. Credit cannot be earned for both BIO 3073 and ES 3073.) Generally offered: Fall, Spring. Differential tuition: \$150.

**BIO 3113. Ichthyology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. This course will focus on form and function, behavior, life history, ecology, and key taxonomic characteristics of most of the orders of fishes. Field trips may be required. (Same as ES 3113. Credit cannot be earned for both BIO 3113 and ES 3113.) Generally offered: Spring. Differential Tuition: \$150. Course Fees: IUS1 \$15; STFB \$40.

**BIO 3123. Comparative Vertebrate Anatomy. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Not recommended for pre-medical and pre-dental students. A comparative analysis of developmental and adult anatomy of vertebrates (including humans). Emphasis is placed on phylogenetic relationships between form, function, and evolution. Generally offered: Spring. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3213. Animal Behavior. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. This course will introduce various approaches to the study of animals and their behavior in natural habitats. The course will examine basic principles derived from studying the evolution, ecology, and development of animals, and use these principles to explain how and why animals behave as they do in particular situations. (Same as NDRB 3213. Credit cannot be earned for both NDRB 3213 and BIO 3213.) Generally offered: Fall, Summer. Spring. Differential Tuition \$150. Course fee: DL01 \$75.

**BIO 3233. Survey of Insects. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Course includes an introduction to basic insect biology, as well as in-depth coverage of insect systematics, including major orders and families. (Same as ES 3233. Credit cannot be earned for both BIO 3233 and ES 3233.) Generally offered: Spring even years. Differential Tuition: \$150.

**BIO 3253. R Coding in Environmental Science and Ecology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1173 or CS 1173 with a grade of at least a 'C-'. This course will teach the management of environmental and ecological data using Program R. The focus will be on the structure and linguistics of data in R and how to integrate R into a data science workflow. (Same as ES 3253. Credit cannot be earned for both BIO 3253 and ES 3253.) Generally offered: Fall. Differential tuition: \$150. Course fee: IUS1 \$15.

**BIO 3263. The Woody Plants. (2-3) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A study of the woody plants, emphasizing the characteristics of family, genus, and species. Includes identification of the common woody plants. Leaf, stem, and flower morphology, anatomy, and collecting techniques. Lecture, laboratory, and fieldwork will be included as part of the course. (Same as ES 3223. Credit cannot be earned for both BIO 3263 and ES 3223.) Generally offered: Fall. Differential Tuition: \$150. Course Fee: STFB \$40.

**BIO 3273. Biology of Flowering Plants. (2-3) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A study of the wildflowers of Texas emphasizing identification of the more common wildflowers, as well as family characteristics. Flower anatomy, plant morphology, and plant-collecting techniques will be included. Lecture, laboratory, and fieldwork will be included as part of the course. (Same as ES 3213. Credit cannot be earned for both BIO 3273 and ES 3213.) Generally offered: Spring. Differential Tuition \$150.

**BIO 3283. Principles of Ecology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1223. A study of the interaction of organisms with their environment, with focus on ecological principles, adaptations of organisms, environmental pollution, and principles of conservation. (Same as ES 3033. Credit cannot be earned for both BIO 3283 and ES 3033.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$150.

**BIO 3292. Principles of Ecology Laboratory. (0-6) 2 Credit Hours.**

Prerequisites: BIO 1223 and completion of or concurrent enrollment in BIO 3283. A field-oriented course emphasizing modern ecological techniques, including examinations of plant and animal populations and measurement of selected chemical and physical parameters. (Same as ES 3042. Credit cannot be earned for both BIO 3292 and ES 3042.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30; STFB \$40.

**BIO 3293. Mammalogy. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A course covering various aspects of the biology of mammals, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips may be required. (Same as ES 3173. Credit cannot be earned for both BIO 3293 and ES 3173.) Generally offered in Fall of odd years. Differential Tuition: \$150. Course Fee: IUS1 \$15.

**BIO 3303. Entomology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A course covering various aspects of the biology of insects, including anatomy, physiology, evolution, behavior, ecology, and biogeography. (Same as ES 3183. Credit cannot be earned for both BIO 3303 and ES 3183.) Generally offered: Spring odd years. Field trips may be required. Differential Tuition: \$150.

**BIO 3323. Evolution. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A discussion of theories and possible mechanisms for evolutionary changes at various levels of organization. (Same as MMI 3323. Credit cannot be earned for both BIO 3323 and MMI 3323.) Generally offered: Spring. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3333. Plants and Society. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. The importance of plants and plant-derived products to human health and wellbeing through the provision of food, pharmaceuticals, and other important natural products. (Formerly listed as BIO 2343 in previous catalogs. Credit cannot be earned for both BIO 3333 and BIO 2343.) Generally offered: Spring. Differential Tuition \$150.

**BIO 3343. Plant Cell Biology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A comprehensive study of the molecular structures and functions of plant cells and their integration into the whole plant system. (Formerly titled "Plant Sciences.") Generally offered: Spring. Differential Tuition \$150.

**BIO 3353. Herpetology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A course covering various aspects of the biology of amphibians and reptiles, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. (Same as ES 3193. Credit cannot be earned for both BIO 3353 and ES 3193.) Field trips may be required. Differential Tuition: \$150. Course Fee: IUS1 \$15.

**BIO 3362. Molecular Biochemistry Laboratory. (1-4) 2 Credit Hours.**

Prerequisites: BIO 2362, CHE 1103, and completion or concurrent enrollment in MAT 1093 or higher. A study of the microscopic, biochemical and molecular techniques used to investigate biochemical reactions and the structure and function of proteins in cells and tissues. Techniques will include; protein extraction, protein characterization, enzyme kinetics, chromatography, western blotting, Immunofluorescence and bioinformatics. (Same as BIO 3522, BIO 3822, NDRB 3362, and BME 3114. Credit cannot be earned for both BIO 3362 and any of the following: BIO 3522, BIO 3822, NDRB 3362, or BME 3114.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30; DL01 \$50.

**BIO 3382. Sophomore Research Initiative Peer Mentor. (0-0) 2 Credit Hours.**

Prerequisites: BIO 3362, completion of the Sophomore Research Initiative, and instructor consent. Student will be a peer mentor for students in the Sophomore Research Initiative (SRI) in a laboratory in which they were previously enrolled, and which they completed with a grade of "A" or "B". Students will work under the guidance of a graduate teaching assistant or laboratory coordinator. Besides assisting in the laboratory, students will be expected to attend group meetings associated with the laboratory, help with setup of the laboratories and complete a written assignment at the end of the semester. Students will not have any student grading responsibility. Cannot be repeated for credit. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30.

**BIO 3413. Physiology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Physiology of systems of higher animals and plants, including circulation, regulation of body fluids, nervous system, muscle, sensory systems, and photosynthesis. Generally offered: Fall, Spring, Summer. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3422. Physiology Laboratory. (1-5) 2 Credit Hours.**

Prerequisite: Completion or concurrent enrollment in BIO 3413. Basic understanding of the physiological processes in living systems employing methods and instruments of biological research. Generally offered: Fall, Spring, Summer. Differential Tuition: \$100. Course Fees: DL01 \$50; IUS1 \$15; L001 \$30.

**BIO 3433. Neurobiology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Anatomy and physiology of nervous systems; the mechanisms of neuronal functions. Same as NDRB 3433. Credit cannot be earned for both BIO 3433 and NDRB 3433. Generally offered: Fall, Spring. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3442. Neurobiology Laboratory. (0-4) 2 Credit Hours.**

Prerequisites: BIO 1203 with a grade of at least a C, and completion of or concurrent enrollment in BIO 3433. Restricted to students who have completed 60 or more hours. A laboratory course emphasizing principles presented in BIO 3433. Same as NDRB 3442. Credit cannot be earned for both BIO 3442 and NDRB 3442. Generally offered: Fall, Spring. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30; DL01 \$50.

**BIO 3513. Biochemistry. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and CHE 3643 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Introduction to biochemistry: amino acids, protein structure, enzymes, lipids, metabolism, nucleic acid structure, bioenergetics, and carbohydrates. (Same as CHE 4303. Credit cannot be earned for both BIO 3513 and CHE 4303.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3523. Advanced Computational Biology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1173 or CS 1173 with a grade of at least a 'C-'. Development and application of computational approaches to biological questions, with focus on formulating interdisciplinary problems as computational problems and then solving these problems using algorithmic techniques. Generally offered: Spring. Differential tuition: \$150. Course fee: IUS1 \$15.

**BIO 3623. Neuropsychopharmacology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. BIO 3433 is recommended. A study of the pharmacology of drugs that affect the function of the central nervous system. Topics include drug-receptor interactions, drugs of abuse, and drugs used to treat mental illness. (Same as NDRB 3623. Credit cannot be earned for both BIO 3623 and NDRB 3623.) Generally offered: Fall. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3642. Clinical Anatomy Laboratory I. (0-6) 2 Credit Hours.**

Prerequisite: BIO 2992 and BIO 3413 with a grade of at least a 'C-'. Concurrent enrollment in 3643 required. Designed for pre-medical and pre-dental students. Not recommended for pre-nursing and allied health students. This is the first laboratory course in a two part series that teaches the structure of the human body at a level required for clinical medicine. Same as BIO 2051. Credit cannot be earned for both BIO 2051 and BIO 3642. Generally offered: Fall. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30.

**BIO 3643. Advanced Physiology I. (3-0) 3 Credit Hours.**

Prerequisite: BIO 2992 and BIO 3413 with a grade of at least a 'C-'. Concurrent enrollment in 3642. This is the first lecture course in a two part series that teaches the structure and functions of the human body at a level required for clinical medicine. The course covers normal physiology, as well as selected diseases. This course will cover foundational basics on the cell, body fluids, the autonomic nervous system, and endocrine system. The ultimate goal is for students to develop an understanding of the integrated functions of the normal body and "problem solving" and "critical thinking" skills in evaluating clinical situations. Same as BIO 2053. Credit cannot be earned for BIO 2053 and BIO 3643. Generally offered: Fall. Differential Tuition: \$150.

**BIO 3652. Clinical Anatomy Laboratory II. (0-6) 2 Credit Hours.**

Prerequisite: BIO 3643 and BIO 3642 with a grade of at least a 'C-'. Concurrent enrollment in BIO 3653 required. Designed for pre-medical and pre-dental students. Not recommended for pre-nursing and allied health students. This is the second laboratory course in a two part series that teaches the structure of the human body at a level required for clinical medicine. Same as BIO 2061. Credit cannot be earned for both BIO 2061 and BIO 3652. Generally offered: Spring. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30.

**BIO 3653. Advanced Physiology II. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3643 and BIO 3642 with a grade of at least a 'C-'. Designed for pre-medical and pre-dental students. Not recommended for pre-nursing and allied health students. This is the second lecture course in a two part series that teaches the structure and functions of the human body at a level required for clinical medicine. The course covers cardiovascular, respiratory, renal, and gastrointestinal; with a final integration section which applies the physiological principles learned to special situations. The ultimate goal is for students to develop an understanding of the integrated functions of the normal body and "problem solving" and "critical thinking" skills in evaluating clinical situations. Same as BIO 2063. Credit cannot be earned for BIO 2063 and BIO 3653. Generally offered: Spring. Differential Tuition: \$150.

**BIO 3663. Human Embryology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Development of the human embryo from fertilization to the birth of the fetus. The origin of various tissues and organs will be followed during development. Environmental and genetic factors that can alter development will be discussed. Same as NDRB 3663. Credit cannot be earned for both BIO 3663 and NDRB 3663. Generally offered: Fall. Differential Tuition: \$150.

**BIO 3713. Microbiology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 1203 and BIO 1223; restricted to students who have completed 60 or more hours; concurrent enrollment in MMI 3722 is recommended for students intending to complete both courses. A comprehensive study of microorganisms, including their composition, morphology, growth, metabolism, classification, ecology, and significance in disease. BIO 1053 cannot substitute for BIO 3713. (Same as MMI 3713. Credit cannot be earned for MMI 3713, BIO 3713, and ES 3103.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3722. Microbiology Laboratory. (0-6) 2 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with at least a C-, and completion of or concurrent enrollment in BIO 3713. Restricted to students with 60 or more hours. Basic microbiology techniques with emphasis on microscopy; cell staining and characterization; species isolation techniques; bacterial cultivation, nutrition, and physical requirements; and the physical and chemical control of microbes. Immunodeficient and pregnant students must contact the Coordinator, Microbiology Teaching Labs, for additional instructions prior to the class start date. BIO 1061 cannot substitute for BIO 3722. Same as MMI 3722. Credit cannot be earned for both BIO 3722 and MMI 3722. Generally offered: Fall, Spring, Summer. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30; DL01 \$50.

**BIO 3743. Bacteriology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 2313 and BIO 3713 with a grade of at least a 'C-'. Restricted to students with at least 60 hours. A study of the phylogeny of prokaryotes; structure and function of prokaryotic cells; ecology and physiological diversity of prokaryotes; growth and control of microorganisms; genetics of bacteria and bacteriophages; bacteria as agents of disease; antibacterials and other chemotherapeutics; human applications of microbiology, microbial genomics, and principles of microbial biotechnology. Same as MMI 3743. Credit cannot be earned for both BIO 3743 and MMI 3743. Generally offered: Fall. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3813. Cell Biology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. BIO 3513 is recommended. A study of cellular molecules and metabolic processes; synthesis and regulation of macromolecules; differential gene expression; membranes and organelles; cytoskeleton; cell cycle and growth of normal and neoplastic cells. (Same as BME 3114 and NDRB 3813. Credit cannot be earned for both BIO 3813 and BME 3114 or BIO 3813 and NDRB 3813.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3913. Molecular Biology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. BIO 3513 is recommended. A study of nucleotides, DNA, replication, recombination, RNA, transcription, genetic code, translation, genomes, and chromosomes. Same as NDRB 3913. Credit cannot be earned for both BIO 3913 and NDRB 3913. Generally offered: Fall, Spring. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 3933. Principles of Cancer Biology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. BIO 3813 is recommended. A study of the underlying molecular and cellular biology involved in carcinogenesis, the roles of oncogenes and tumor suppressor genes in cancer development and progression, and modern technologies in cancer screening, diagnosis, treatments, and prevention. Upon completion of the class, students should have gained a basic understanding of the mechanisms by which tumors arise and progress to cancer, potential therapeutic targets in cancer treatments, and an individual's actions that are expected to decrease the chances of cancer development. Same as NDRB 3993. Credit cannot be earned for both BIO 3933 and NDRB 3993. Generally offered: Fall, Spring. Differential Tuition \$150.

**BIO 4033. Conservation Biology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3283 with a grade of at least a 'C-'. The class topics will include studying the nature of the biosphere, threats to its integrity, and ecologically sound responses to these threats. Also included will be the origin and preservation of biotic diversity, how the rich variety of plant and animal life around us arose, how it has been maintained by natural processes, and how we can prevent its destruction. (Same as ES 4213. Credit cannot be earned for both BIO 4033 and ES 4213.) Generally offered: Fall. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 4043. Desert Biology. (2-3) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours, or consent of instructor. Concurrent enrollment in BIO 4233 and BIO 4241 required. A study of the deserts of the world with an emphasis on U.S. deserts. Adaptations of plants and animals and their responses to desert conditions, as well as examinations of desert climatic patterns, geology, and natural history. Lecture, laboratory, and fieldwork will be included. (Same as ES 4123. Credit cannot be earned for both BIO 4043 and ES 4123.) Generally offered: Summer. Differential Tuition \$150.

**BIO 4053. Wildlife Ecology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 3283 with a grade of at least a 'C-'. Major environmental factors affecting wildlife; structure and behavior of wildlife populations; regional wildlife communities and their conservation. Field studies will allow students to observe and apply classroom topics. (Same as ES 4243. Credit cannot be earned for both BIO 4053 and ES 4243.) Generally offered: Fall. Differential Tuition: \$150.

**BIO 4063. Ornithology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A course covering various aspects of the biology of birds, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips will be included. (Same as ES 3163. Credit cannot be earned for both BIO 4063 and ES 3163.) Generally offered: Spring. Differential Tuition \$150.

**BIO 4143. Developmental Biology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. BIO 3813 is recommended. Overview of developmental biology focusing on the origins of classical concepts as well as modern molecular approaches. Emphasis will be placed on the mechanisms underlying developmental processes using both invertebrate and vertebrate examples. Subjects include axis formation, induction, morphogenesis, embryonic pattern formation, cell differentiation, and organogenesis. (Formerly listed as BIO 3143 in previous catalogs. Same as NDRB 4143. Credit cannot be earned for both BIO 4143 and BIO 3143 or BIO 4143 and NDRB 4143.) Generally offered: Fall. Differential Tuition: \$150.

**BIO 4233. Field Biology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'; restricted to students who have completed 60 or more hours, or consent of instructor. Corequisites: BIO 4241 and BIO 4033. A field-oriented course offering the opportunity for practical experience observing, collecting, and identifying Texas plants and animals. (Same as ES 4133. Credit cannot be earned for both BIO 4233 and ES 4133.) Generally offered: Summer. Differential Tuition \$150. Course Fees: IUS1 \$15; L001 \$30.

**BIO 4241. Field Biology Laboratory. (0-3) 1 Credit Hour.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours, or consent of instructor. Concurrent enrollment in BIO 4233 and BIO 4043 required. A field-oriented course offering the opportunity for practical experience observing, collecting, and identifying Texas plants and animals. (Same as ES 4111. Credit cannot be earned for both BIO 4241 and ES 4111.) Generally offered: Summer. Differential Tuition \$50. Course Fees: IUS1 \$15; L001 \$30.

**BIO 4263. River Ecosystems. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3283 with a grade of at least a 'C-'. This course examines the physical, chemical, and biological factors that determine biodiversity and the structure and function of aquatic and riparian ecosystems. Key ecological and hydrogeomorphology concepts and their application to environmental concerns are covered. Same as ES 4263. Credit cannot be earned for both BIO 4263 and ES 4263. Generally offered: Spring of even years. Differential Tuition: \$150.

**BIO 4273. Fish Ecology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3283 with a grade of at least a 'C-'. A study of the biotic and abiotic factors affecting the diversity and distribution of fishes, with a focus on North American freshwater fishes. This course will include (1) lectures and discussions covering patterns and processes in fish ecology; and (2) a collaborative research project covering computational techniques used in fish ecology. Same as ES 4273. Credit cannot be earned for both BIO 4273 and ES 4273. Generally offered: Fall of even years. Differential Tuition: \$150.

**BIO 4283. Plant-Soil-Microbe Interactions. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3283 with a grade of at least a 'C-'. This course focuses on the microbial groups which live in soils and among plant species and methodologies used to understand their interaction. Same as ES 4283. Credit cannot be earned for both BIO 4283 and ES 4283. Generally offered: Fall of even years. Differential Tuition: \$150.

**BIO 4303. Aquatic Ecology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3283 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Study of aquatic ecosystems including streams, wetlands, and lakes. Topics include watershed processes, biological communities, physical habitats, nutrient cycling, energy flow, and management issues. The course culminates with individual research projects focused on local watersheds. Field trips may be required. Same as ES 4023. Credit cannot be earned for both BIO 4303 and ES 4023. Generally offered: Spring. Differential Tuition: \$150. Course Fee: STFB \$40.

**BIO 4313. Plant Physiological Ecology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3283 with a grade of 'C-' or better. Survey of physiological approaches to understanding plant-environment interactions from the functional perspective. Same as ES 4033. Credit cannot be earned for both BIO 4313 and ES 4033. Generally offered: Fall of odd years. Differential Tuition: \$150.

**BIO 4323. Restoration Ecology. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 or BIO 3283, or equivalents. Applies ecological principles to the restoration of disturbed terrestrial, wetland, and aquatic ecosystems. Includes the restoration of soils and waterways, of flora and fauna, and of natural ecological processes such as plant succession and nutrient cycling. Same as ES 4233. Credit cannot be offered for both BIO 4323 and ES 4233. Generally offered: Spring. Differential Tuition: \$150.

**BIO 4453. Endocrinology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Molecular, cellular, and physiological effects of hormones in health and disease. Topics include molecular mechanisms of hormone action in reproductive physiology, growth, and development, as well as defects in hormonal regulation underlying clinically important syndromes (e.g., diabetes, hypertension, osteoporosis, and cancer). Same as NDRB 4453. Credit cannot be earned for BIO 4453 and NDRB 4453. Generally offered: Fall. Differential Tuition: \$150. Course fee: DL01 \$75.



**BIO 4473. Advanced Clinical Medicine and Pathology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3013 with a grade of at least a 'C-'. Advanced concepts of human disease, diagnosis, and underlying pathology. Same as MMI 4473. Credit cannot be earned for both BIO 4473 and MMI 4473. Generally offered: Spring. Differential Tuition \$150.

**BIO 4483. Medical Mycology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 3713 and BIO 3722 with a grade of at least a 'C-'. Comprehensive study of causative agents, pathogenesis, and treatment of human fungal diseases. Same as MMI 4483. Credit cannot be earned for both BIO 4483 and MMI 4483. Generally offered: Spring. Differential Tuition \$150. Course fee: DL01 \$75.

**BIO 4583. Emergent Properties of Neural Circuits. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3433 with a grade of at least a 'C-'. Principles of cellular neurophysiology and neuroanatomy are used to explore the computational operations performed by neurons and networks of neurons. Same as NDRB 4583. Credit cannot be earned for both BIO 4583 and NDRB 4583. Generally offered: Spring. Differential Tuition: \$150.

**BIO 4643. Medicinal Plants. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. BIO 3513 is recommended. Ethnobotanical, biochemical, and pharmacological aspects of some of our most important plant-derived drugs. Generally offered: Fall. Differential Tuition: \$150.

**BIO 4723. Virology. (3-0) 3 Credit Hours.**

Prerequisite: BIO 2313 and BIO 3513 with a grade of at least a 'C-'. Introduction to the molecular, genetic, and biological properties of viruses. Course will cover the basic concepts of virus structure, replication, virus/host interactions, pathogenesis, and evolution. Same as MMI 4723. Credit cannot be earned for both BIO 4723 and MMI 4723. Generally offered: Fall. Differential Tuition: \$150.

**BIO 4743. Immunology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'; restricted to students who have completed 60 or more hours; concurrent enrollment in BIO 4752 is recommended. A study of the properties of antigens and antibodies and current concepts of humoral and cell-mediated immunity and the cells involved. Same as MMI 4743. Credit cannot be earned for both BIO 4743 and MMI 4743. Generally offered: Fall, Spring, Summer. Differential Tuition: \$150.

**BIO 4752. Immunology Laboratory. (0-4) 2 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, BIO 2313, BIO 2362 (or BIO 2322 in previous catalogs), and completion of or concurrent enrollment in BIO 4743, all with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. Laboratory applications of principles presented in BIO 4743. (Formerly listed as BIO 4751 in previous catalogs. Same as MMI 4752. Credit cannot be earned for both BIO 4752 and MMI 4752.) Generally offered: Fall, Spring, Summer. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30; DL01 \$50.

**BIO 4763. Parasitology. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203, BIO 1223, and BIO 2313 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. BIO 3713 is strongly recommended. This course is focused on eukaryotic parasites of medical or veterinary importance: their life cycles, epidemiology, control, and the diseases and pathology they cause. Evolutionary aspects of host-parasite interactions, the diversity of parasite biology, and the interrelationships between parasitology, vector biology, and public health will be emphasized. Same as MMI 4763. Credit cannot be earned for both BIO 4763 and MMI 4763. Generally offered: Spring. Differential Tuition \$150. Course fee: DL01 \$75.

**BIO 4773. Microbial Ecology and Metagenomics. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1053 and BIO 2313. This course will provide an overview of microbial ecology principles and application of microbial ecological approaches to understand microbial structure and function across environments, including the soil, freshwater and marine environments. The course will focus its content on prokaryotes and fungi. An emphasis in this course will be on learning foundational concepts in microbiome science and applying concepts to laboratory and computational techniques through hands-on experiments. Same as MMI 4773. Credit cannot be earned for both BIO 4773 and MMI 4773. Generally offered: Fall, Spring. Differential Tuition: \$150.

**BIO 4783. Microbial Genomes and Virulence. (3-0) 3 Credit Hours.**

Prerequisite: BIO 2313. MMI 3713 is recommended. This course is focused on microbial pathogens of medical importance. Insights into the genome makeup and virulence inventories of pathogens is essential for understanding their biology, epidemiology, human diseases they cause, and trajectories of pathogen evolution. Topics covered include the basic concepts of genome sequencing, pathogen-specific virulence traits, and the role of genetic exchange in genome evolution, speciation, fitness, and pathogenicity. Same as MMI 4783. Credit cannot be earned for both BIO 4783 and MMI 4783. Generally offered: Spring. Differential Tuition \$150. Course fee: DL01 \$75.

**BIO 4813. Brain and Behavior. (3-0) 3 Credit Hours.**

Prerequisites: BIO 1203 and BIO 1223 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. This course explores the brain basis of behavior, with a focus on understanding the neurophysiological, neurochemical, and neuroanatomical underpinnings for a variety of simple and complex behaviors. Students will explore topics such as sensation and perception, pain, movement, sleep, biological rhythms, emotions, addiction, learning and memory, and neurodevelopment. The topics are grounded with examples of typical human behavior and disorders, such as Parkinson's disease, autism, schizophrenia, and psychopathology. Same as NDRB 4813. Credit cannot be earned for more than one of BIO 4813, PSY 4183, or NDRB 4813. Generally offered: Fall. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 4823. Cognitive Neuroscience. (3-0) 3 Credit Hours.**

Prerequisite: BIO 3433 or BIO 4813 or PSY 4183, with a grade of at least a C-, or consent of instructor. The biological basis of cognition, including perception, attention, learning, memory, emotion, language, and executive function. The course introduces students to the use of human neuroimaging experiments and clinical population, as well as research with other species, to study the brain basis of complex behavior and cognitive disorders, such as memory loss, language impairment, and developmental disorders. Same as NDRB 4823. Credit cannot be earned for both BIO 4823 and NDRB 4823. Generally offered: Spring. Differential Tuition \$150.

**BIO 4911. Independent Study. (0-0) 1 Credit Hour.**

Prerequisite: Permission in writing (form available) from the instructor, an undergraduate academic advisor, the Department Chair, and the Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Only 6 semester credit hours of BIO 3043, BIO 4911-3, BIO 4923 and BIO 4993, in any combination, can be taken as BIO electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. Differential Tuition: \$50.

**BIO 4912. Independent Study. (0-0) 2 Credit Hours.**

Prerequisite: Permission in writing (form available) from the instructor, an undergraduate academic advisor, the Department Chair, and the Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Only 6 semester credit hours of BIO 3043, BIO 4911-3, BIO 4923 and BIO 4993, in any combination, can be taken as BIO electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. Differential Tuition: \$100.

**BIO 4913. Independent Study. (0-0) 3 Credit Hours.**

Prerequisite: Permission in writing (form available) from the instructor, an undergraduate academic advisor, the Department Chair, and the Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Only 6 semester credit hours of BIO 3043, BIO 4911-3, BIO 4923 and BIO 4993, in any combination, can be taken as BIO electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. Differential Tuition: \$150.

**BIO 4923. Laboratory Research: Biology Concentrations. (0-0) 3 Credit Hours.**

Prerequisite: Permission in writing (form available in the Biology Department Office) from the faculty mentor, the student's advisor, the Department Chair, and the Dean of the College. Supervised laboratory research mentored by a faculty member engaged in active research within the student's designated area of concentration. May be repeated for credit, but no more than 6 semester credit hours will apply to a bachelor's degree. Only 6 semester credit hours of BIO 3043, BIO 4911-3, BIO 4923 and BIO 4993, in any combination, can be taken as BIO electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. Differential Tuition: \$150.

**BIO 4951. Special Studies in Biology. (1-0) 1 Credit Hour.**

An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. No more than 6 semester credit hours of BIO 2953, BIO 4951, or BIO 4953 can be applied to a B.S. degree in Biology or Microbiology and Immunology. Differential Tuition: \$50.

**BIO 4953. Special Studies in Biology. (3-0) 3 Credit Hours.**

An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. No more than 6 semester hours of BIO 2953, BIO 4951, or BIO 4953 can be applied to a B.S. degree in Biology or Microbiology and Immunology. Generally offered: Fall, Spring, Summer. Differential Tuition: \$150. Course fee: DL01 \$75.

**BIO 4981. Senior Seminar in Microbiology and Immunology. (1-0) 1 Credit Hour.**

Prerequisite: Senior status, a minimum of 90 semester credit hours. This course is only open to seniors in the Microbiology and Immunology degree program. Students will learn how to interpret the scientific literature and to organize and present scientific research findings as reported in the current literature. May be repeated for credit. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). Generally offered: Fall, Spring. Differential Tuition: \$50. Course fee: DL01 \$25.

**BIO 4993. Honors Research. (0-0) 3 Credit Hours.**

Prerequisite: Students taking this course must have approval by the Honors College or College Honors Committee, must be a Biology major, must be either a member of the Honors College or pursuing College of Sciences Honors, and must be in the last two semesters of study. Supervised research and preparation of an Honors Thesis. May be repeated for credit with approval, but no more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Only 6 semester credit hours of BIO 4911-3, BIO 4923 and BIO 4993, in any combination, can be taken as BIO electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring. Differential Tuition: \$150.

## Environmental Sciences (ES) Courses

**ES 1003. Survey Topics in Environmental Studies. (3-0) 3 Credit Hours.**

A broad based survey course intended to provide a comprehensive introduction to the multidisciplinary field of environmental studies. This course examines the ecological, social, and political-economic aspects of contemporary environmental issues from an interdisciplinary perspective. May be applied toward the Core Curriculum requirement in Social and Behavioral Sciences. Generally offered: Fall and Spring. Course Fees: LRS1 \$46.20; STSI \$21.60.

**ES 1111. Environmental Botany Laboratory. (0-3) 1 Credit Hour. (TCCN = BIOL 1111)**

Laboratory studies to accompany Environmental Botany Lecture. Selected laboratories pertaining to the structure and function of plants. Generally offered: Fall and Spring. Course Fees: IUS1 \$15; L001 \$20; LRS1 \$15.40; STSI \$7.20.

**ES 1113. Environmental Botany. (3-0) 3 Credit Hours. (TCCN = BIOL 1311)**

Study of structure and function of plant cells, tissues, and organs. Includes an evolutionary survey and life histories of the following representative groups: algae, fungi, mosses, liverworts, ferns, and seed producing organisms. Plant reproductive and functional interactions with their environment and with humans. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall and Spring. Course Fees: IUS1 \$15; LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

**ES 1121. Environmental Zoology Laboratory. (0-3) 1 Credit Hour. (TCCN = BIOL 1113)**

Laboratory studies to accompany Environmental Zoology Lecture. Selected laboratories pertaining to the taxonomy, molecular biology, and ecology of animals. Generally offered: Fall and Spring. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20.

**ES 1123. Environmental Zoology. (3-0) 3 Credit Hours. (TCCN = BIOL 1313)**

Study of the principles of taxonomy, molecular biology, and ecology as they relate to animal form and function, diversity, behavior, and evolution. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall and Spring. Course Fees: LRC1 \$12; LRS1 \$46.20; STSI \$21.60; DL01 \$75.

**ES 1211. Environmental Geology Laboratory. (0-3) 1 Credit Hour. (TCCN = GEOL 1105)**

Laboratory studies to accompany Environmental Geology Lecture. Selected laboratories pertaining to urban and regional land use planning. Generally Offered: Fall and Spring. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STFE \$40; STSI \$7.20.

**ES 1213. Environmental Geology. (3-0) 3 Credit Hours. (TCCN = GEOL 1305)**

The earth as a habitat. Interrelationships between humans and the environment. Geologic factors in urban and regional land use planning. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall and Spring. Course Fees: LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

**ES 1314. Environmental Statistics. (3-3) 4 Credit Hours. (TCCN = MATH 1442)**

Collection, analysis, presentation, and interpretation of environmental data, and probability. Analysis includes descriptive statistics, correlation and regression, confidence intervals and hypothesis testing. Use of appropriate technology, including statistical software. Generally offered: Fall and Spring. Course Fees: IUS1 \$15; LRS1 \$61.60; STSI \$28.80.

**ES 2013. Introduction to Environmental Science I. (3-0) 3 Credit Hours. (TCCN = ENVR 1301)**

An introduction to the scientific principles, concepts, and methodologies needed to understand the interactions of the biotic component of the natural world, to identify and analyze environmental problems within the biotic component of natural world, risk assessment of these environmental problems, and to examine alternate solutions. General attention is given to the biotic concepts of growth, processes, and changes occurring in ecosystems and social structures. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall, Spring. Course Fees: DL01 \$75; LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

**ES 2021. Introduction to Environmental Science I Laboratory. (0-3) 1 Credit Hour.**

Prerequisite: Concurrent enrollment in ES 2013 is recommended. Qualitative and quantitative methods in the study of biotic environmental systems. Generally offered: Fall, Spring. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20.

**ES 2023. Introduction to Environmental Science II. (3-0) 3 Credit Hours. (TCCN = ENVR 1302)**

An introduction to the scientific principles, concepts, and methodologies needed to understand the interactions of the abiotic component of the natural world, to identify and analyze environmental problems within the abiotic component of the natural world, risk assessment of these environmental problems, and to promote environmental sustainability. General attention is given to the abiotic environmental factors including natural hazards, pollution processes, energy resources, sustainability, and changes occurring in ecosystems. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall, Spring. Course Fees: LRC1 \$12; LRS1 \$46.20; STSI \$21.60; DL01 \$75.

**ES 2031. Introduction to Environmental Science II Laboratory. (0-3) 1 Credit Hour.**

Prerequisite: Concurrent enrollment in ES 2023 is recommended. Qualitative and quantitative methods in the study of abiotic environmental systems. Generally offered: Fall, Spring. Course Fees: IUS1 \$15; L001 \$30; LRS1 \$15.40; STSI \$7.20.

**ES 2113. Fundamentals of Geographic Information Systems (GIS). (2-2) 3 Credit Hours.**

This course will serve as a basic introduction to the concepts and techniques of utilizing a Geographic Information System (GIS) to study and model environmental issues. In lecture and laboratory, students will study methods of querying, analyzing, creating, and displaying GIS data utilizing industry standard software. Students will also be introduced to using the Global Positioning System (GPS) as a means for creating GIS data. Generally offered: Fall and Spring. (Same as GEO 2113. Credit cannot be earned for both ES 2113 and GEO 2113.) Course Fees: IUS1 \$15; LRS1 \$46.20; STSI \$21.60.

**ES 3033. Environmental Ecology. (3-0) 3 Credit Hours.**

Prerequisites: ES 2013 and ES 2023, or equivalents. Examination of the interactions of biotic and abiotic systems, including interactions of plants, animals, and the environment. (Formerly ES 3034. Credit can only be earned for one of the following: ES 3033, ES 3034, or BIO 3283.) Generally offered: Fall, Spring. Differential Tuition: \$150.

**ES 3042. Environmental Ecology Laboratory. (0-6) 2 Credit Hours.**

Prerequisites: ES 2013, ES 2021, ES 2023, and ES 2031, or equivalents; concurrent enrollment in ES 3033 is recommended. A field-oriented course emphasizing modern ecological techniques, including examinations of plant and animal populations and measurement of selected chemical and physical parameters. (Same as BIO 3292. Credit cannot be earned for both ES 3042 and BIO 3292.) Generally offered: Fall, Spring. Differential Tuition: \$100. Course Fees: IUS1 \$15; L001 \$30; STFE \$40.

**ES 3053. Environmental Remediation. (3-0) 3 Credit Hours.**

Prerequisites: CHE 1083, CHE 1093, ES 2013, and ES 2023, or equivalents. This course will focus on the fundamentals associated with environmental remediation in relation to the overall environmental quality and protection. Topics covered include contaminant fate and transport; physical, chemical, and biological processes/characteristics of the air, soil, and water; remediation/restoration methods; environmental monitoring; environmental assessments; environmental regulations; and water/wastewater treatment. (Formerly ES 3054. Credit cannot be earned for both ES 3053 and ES 3054.) Generally offered: Spring. Differential Tuition: \$150.

**ES 3073. Environmental Rhetoric and Technical Communication. (3-0) 3 Credit Hours.**

Prerequisite: ENG 2413. Restricted to students who have completed 60 or more hours. This course focuses on rhetoric, ecology, and technical/scientific communication in order to develop interdisciplinary, team-based, and applied research projects. This advanced professional writing and rhetoric course will examine ecological communications as an archetypal example of specialized technical communication. (Same as BIO 3073. Credit cannot be earned for both ES 3073 and BIO 3073.) Generally offered: Fall, Spring. Differential tuition: \$150.

**ES 3103. Environmental Microbiology. (3-0) 3 Credit Hours.**

Prerequisites: CHE 1083, CHE 1093, ES 2013, and ES 2023, or equivalents; or consent of instructor. This course will survey environmental microbiology and will emphasize microbial interactions in terrestrial and aquatic environments as well as the fate of microbial pathogens. Topics covered include microbial environments, detection of bacteria and their activities in the environment, microbial biogeochemical cycling, bioremediation of organic and inorganic pollutants, and water quality. (Formerly ES 3104. Credit can only be earned for one of the following: ES 3103, ES 3104, or BIO 3713.) Generally offered: Fall. Differential Tuition: \$150.

**ES 3113. Ichthyology. (3-0) 3 Credit Hours.**

Prerequisites: ES 2013, ES 2021, ES 2023, and ES 2031, or equivalents. Study of fishes, and includes a wide range of topics including taxonomy, systematics, and biogeography, anatomy and physiology, and behavior and ecology. This course will focus on form and function, behavior, life history, ecology, and key taxonomic characteristics of most of the orders of fishes. Field trips may be required. Same as BIO 3113, credit cannot be earned for both BIO 3113 and ES 3113. Generally offered: Spring. Differential Tuition: \$150. Course Fees: IUS1 \$15; STFE \$40.

**ES 3121. Introduction to Soils Laboratory. (0-3) 1 Credit Hour.**

Prerequisites: CHE 1083 and CHE 1093, or equivalents. Laboratory exercise and field trips designed to develop student competency in soil description, analysis, and assessment. Generally offered: Fall and Spring. Course Fees: IUS1 \$15; L001 \$30. Differential Tuition: \$50.

**ES 3123. Introduction to Soils. (3-0) 3 Credit Hours.**

Prerequisites: CHE 1083 and CHE 1093, or equivalents. A study of soil properties and processes and relationships to land use, plant growth, environmental quality, and society. Generally offered: Fall and Spring. Differential Tuition: \$150.

**ES 3133. Oceanography. (3-0) 3 Credit Hours.**

Prerequisite: ES 1213 or equivalent. Description of the oceans. Emphasis on relations of biology, chemistry, geology, and physics in marine environments. Examination of relationships and interactions at macro and micro scales in the ocean. Field trips may be required. (Same as GEO 3163. Credit cannot be earned for both ES 3133 and GEO 3163.) Generally Offered: Spring of even years. Differential Tuition: \$150.

**ES 3141. Watershed Processes Laboratory. (0-3) 1 Credit Hour.**

Prerequisites: ES 2013, ES 2023, ES 1213, and ES 2113, or equivalents. Laboratory exercises and field trips designed to develop an understanding of watershed processes, watershed assessment, and watershed management. Generally offered: Fall and Spring. Differential Tuition: \$50. Course Fees: IUS1 \$15; L001 \$30; STFE \$40.

**ES 3143. Watershed Processes. (3-0) 3 Credit Hours.**

Prerequisites: ES 2013, ES 2023, ES 1213, and ES 2113, or equivalents. This course focuses on watershed processes, watershed assessment, and watershed management. Generally offered: Fall and Spring. Differential Tuition: \$150. Course Fee: STFE \$40.

**ES 3153. Environmental Chemistry. (3-0) 3 Credit Hours.**

Prerequisites: CHE 1083, CHE 1093, ES 2013, and ES 2023, or equivalents. This course explores the chemistry of the environment, the chemistry underlying environmental problems, and solutions to environmental problems. Emphasis is placed on thermodynamics and kinetics of reaction cycles; sources, sinks, and transport of chemical species; and quantitation of chemical species. Examples are selected from the chemistry of natural and contaminated air, water, and soil. (Same as CE 4613. Credit cannot be earned for both ES 3153 and CE 4613.) Generally offered: Spring. Differential Tuition: \$150.

**ES 3163. Ornithology. (3-0) 3 Credit Hours.**

Prerequisite: ES 2013 and ES 2023, or equivalents. A course covering various aspects of the biology of birds, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips may be required. (Same as BIO 4063. Credit cannot be earned for both ES 3163 and BIO 4063.) Generally offered: Spring of even years. Course Fees: Differential Tuition: \$150. Course Fee: IUS1 \$15.

**ES 3173. Mammalogy. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 or BIO 3283, or equivalents. A course covering various aspects of the biology of mammals, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips may be required. (Same as BIO 3293. Credit cannot be earned for both ES 3173 and BIO 3293.) Generally offered: Fall of odd years. Differential Tuition: \$150. Course Fee: IUS1 \$15.

**ES 3183. Entomology. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 or ES 3083 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. A course covering various aspects of the biology of insects, including anatomy, physiology, evolution, behavior, ecology, and biogeography. (Same as BIO 3303. Credit cannot be earned for both BIO 3303 and ES 3183.) Generally offered: Spring odd years. Field trips may be required. Differential Tuition: \$150.

**ES 3193. Herpetology. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 or BIO 3283, or equivalents. A course covering various aspects of the biology of amphibians and reptiles, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Field trips may be required. (Same as BIO 3353. Credit cannot be earned for both ES 3193 and BIO 3353.) Generally offered: Fall of odd years. Differential Tuition: \$150. Course Fee: IUS1 \$15.

**ES 3203. Environmental Law. (3-0) 3 Credit Hours.**

Present-day environmental enabling acts and regulations will be covered, with emphasis on federal acts, such as the National Environmental Policy Act, Clean Water Act, Resource Conservation and Recovery Act, and associated regulations. Generally offered: Fall and Spring. Differential Tuition: \$150.

**ES 3213. Biology of Flowering Plants. (2-3) 3 Credit Hours.**

Prerequisite: Junior or senior status; a minimum of 60 semester credit hours. A study of the wildflowers of Texas emphasizing identification of the more common wildflowers, as well as family characteristics, flower anatomy, plant morphology, and plant-collecting techniques will be included. Lecture, laboratory, and fieldwork will be included as part of the course. (Same as BIO 3273. Credit can only be earned for ES 3213 or BIO 3273.) Generally offered: Spring. Differential Tuition: \$150. Course Fees: L001 \$30; STFE \$40.

**ES 3223. Woody Plants. (2-3) 3 Credit Hours.**

Prerequisite: Junior or senior status; a minimum of 60 semester credit hours. A study of the woody plants emphasizing the characteristics of family, genus, and species. Includes identification of the common woody plants. Leaf, stem, and flower morphology, anatomy, and collecting techniques. Lecture, laboratory, and fieldwork will be included as part of the course. (Same as BIO 3263. Credit cannot be earned for both ES 3223 and BIO 3263.) Generally offered: Fall. Differential Tuition: \$150. Course Fees: L001 \$30; STFE \$40.

**ES 3233. Survey of Insects. (3-0) 3 Credit Hours.**

Prerequisites: ES 2013 and ES 2023 with a grade of at least a C-, and junior or senior status. Insect systematics, including major orders and families. (Same as BIO 3233. Credit cannot be earned for both BIO 3233 and ES 3233.) Generally offered: Spring even years. Differential Tuition: \$150.

**ES 3253. R Coding in Environmental Science and Ecology. (3-0) 3 Credit Hours.**

Prerequisite: ES 2113. Restricted to students who have completed 60 or more hours. This course will teach the management of environmental and ecological data using Program R. The focus will be on the structure and linguistics of data in R and how to integrate R into a data science workflow. (Same as BIO 3253. Credit cannot be earned for both ES 3253 and BIO 3253.) Generally offered: Spring even years. Differential Tuition: \$150.

**ES 3303. Sustainable Development. (3-0) 3 Credit Hours.**

Prerequisite: ES 2013 and ES 2023. Restricted to students who have completed 60 or more hours. This course will focus on addressing the challenges of sustainability and development with actionable knowledge for innovating solutions to the world's most pressing problems like climate change, poverty and inequality, and biodiversity loss and ecosystem degradation. Generally offered: Spring even years. Differential Tuition: \$150.

**ES 3313. Advanced Geographic Information Systems (GIS). (3-0) 3 Credit Hours.**

Prerequisite: ES 2113 or equivalent. This course is an undergraduate level course directed at developing more advanced Geographic Information Systems skills. The class is not introductory, and students will begin using more advanced analysis tools in ESRI GIS software (ArcGIS 10.3). Applications of the technology for scientific discovery and exploration will be used as case study examples. Generally offered: Fall of odd years. Differential Tuition: \$150.

**ES 3953. Topics in Environmental Science. (3-0) 3 Credit Hours.**

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Field trips may be required. May be repeated for credit when topics vary. Generally offered: Fall and Spring. Differential Tuition: \$150.

**ES 4023. Aquatic Ecology. (3-0) 3 Credit Hours.**

Prerequisites: ES 3033 and ES 3042, or equivalents. A survey of physiological approaches to understanding plant-environment interactions from the functional perspective. (Same as BIO 4303. Credit cannot be earned for both ES 4023 and BIO 4303.) Generally offered: Fall of even years. Differential Tuition: \$150.

**ES 4033. Plant Physiological Ecology. (3-0) 3 Credit Hours.**

Prerequisites: ES 3033 and ES 3042, or equivalents. A survey of physiological approaches to understanding plant-environment interactions from the functional perspective. (Same as BIO 4313. Credit cannot be earned for both ES 4033 and BIO 4313.) Generally offered: Fall of even years. Differential Tuition: \$150.

**ES 4103. Global Change. (3-0) 3 Credit Hours.**

Prerequisites: CHE 1083, CHE 1093, ES 2013, and ES 2023, or equivalents; and junior or senior status. Changes in the global distribution of plants and animals and the causes of the changes will be examined. Factors that are apparently coupled to changes in these distributions will be examined including, but not limited to, atmospheric composition change and temperature change. Additionally, examination of the impact of humans and their activities on the environment: their effect on aquatic, marine, and terrestrial plant, animal, and human resources. (Formerly ES 4104. Credit cannot be earned for both ES 4103 and ES 4104.) Generally offered: Fall and Spring. Differential Tuition: \$150.

**ES 4111. Field Biology Laboratory. (0-3) 1 Credit Hour.**

Prerequisite: Junior or senior status: a minimum of 60 semester credit hours, or consent of instructor; concurrent enrollment in ES 4113 is recommended. A field-oriented course offering the opportunity for practical experience observing, collecting, and identifying Texas plants and animals. (Same as BIO 4241. Credit cannot be earned for both ES 4111 and BIO 4241.) Generally offered in Summer. Differential Tuition: \$50. Course Fee: IUS1 \$15.

**ES 4113. Field Biology. (3-0) 3 Credit Hours.**

Prerequisite: Junior or senior status: a minimum of 60 semester credit hours, or consent of instructor; concurrent enrollment in ES 4111 is recommended. A study of the natural history of plants and animals in their native environment. Techniques for the identification of birds, mammals, reptiles, amphibians, insects, and the dominant flowering plants will be discussed. (Same as BIO 4233. Credit cannot be earned for both ES 4113 and BIO 4233.) Generally offered: Summer. Differential Tuition: \$150. Course Fee: IUS1 \$15.

**ES 4123. Desert Biology. (3-0) 3 Credit Hours.**

Prerequisite: Junior or senior status: a minimum of 60 semester credit hours, or consent of instructor. An introduction to wildlife biology and management including ecological principles dealing with ecosystems, natural communities, and populations. The importance of animal behavior, the availability of food, cover, wildlife diseases, predators, hunting, and trapping will be included. Field studies will allow students to observe and apply classroom topics. (Same as BIO 4043. Credit cannot be earned for both ES 4123 and BIO 4043.) Generally offered: Summer. Differential Tuition: \$150. Course Fee: IUS1 \$15.

**ES 4133. Natural Resource Policy and Administration. (3-0) 3 Credit Hours.**

Prerequisite: Junior or senior status. Factors in evolution of forest, range, wildlife, and related natural resources administration and policies in the United States; policy components; policy formation implementation, administration, and change processes; introduction to criteria for evaluating effectiveness of policies and administration. Same as BIO 4233, credit cannot be earned for both BIO 4233 and ES 4133. Generally offered: Spring. Differential Tuition: \$150.

**ES 4153. Introduction to Sustainability. (3-0) 3 Credit Hours.**

Prerequisites: ES 2023 and junior or senior status: a minimum of 60 semester credit hours, or consent of instructor. This course will examine the major environmental issues and trends happening in modern society from a scientific and practical perspective, including biodiversity, population, food and water resources, climate change, energy, public health, and the overall forecast for the environment for the next several decades. Differential Tuition: \$150. Course fee: DL01 \$75.

**ES 4163. Renewable Energy. (3-0) 3 Credit Hours.**

Prerequisites: ES 2023 and junior or senior status: a minimum of 60 semester credit hours, or consent of instructor. This course is an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. Generally offered: Fall of even years. Differential Tuition: \$150.

**ES 4173. Waste Water Treatment. (2-3) 3 Credit Hours.**

Prerequisite: ES 2023 and junior or senior status: a minimum of 60 semester credit hours, or consent of instructor. The application of chemical, biochemical, and physical processes to water treatment, wastewater treatment, and pollution control. Generally offered: Spring of even years. Differential Tuition: \$150. Course Fees: IUS1 \$15; STFE \$40.

**ES 4183. Environmental Toxicology. (3-0) 3 Credit Hours.**

Prerequisites: CHE 1083, CHE 1093, ES 2013, and ES 2023, or equivalents. Examination of advanced or specialized hazardous or toxic waste treatment methods. Emphasis will be on physical, chemical, and biological processes in treatment and processing of hazardous waste materials. Generally offered: Spring. Differential Tuition: \$150.

**ES 4193. Planning and Response to Environmental Disasters. (3-0) 3 Credit Hours.**

Prerequisites: CHE 1083, CHE 1093, ES 2013, and ES 2023, or equivalents. Mitigation of preparation for, response to, and recovery from environmental disasters. Generally offered: Fall of even years. Differential Tuition: \$150.

**ES 4203. Environmental Assessment. (3-0) 3 Credit Hours.**

Prerequisites: ES 2013 and ES 2023, or equivalents. This course evaluates the framework of an impact assessment and details regarding the environment (air, water, soil), its pollutants (atmospheric, noise, water, solid waste), their impacts (physical, social, economic), relevant regulations, and pollution minimization or management strategies. Students use this information to review and comment on an existing Environmental Impact Statement (EIS). Generally offered: Fall and Spring. Differential Tuition: \$150.

**ES 4212. Senior Seminar. (2-0) 2 Credit Hours.**

Prerequisite: Senior status: Environmental Science majors and a minimum of 90 credit hours. The techniques of seminar presentation will be studied by preparing and presenting individual seminars on topics of interest. Enrollment for credit is limited to, and required of, all senior students majoring in environmental studies. (Formerly ES 4211. Credit cannot be earned for both ES 4212 and ES 4211). Generally offered: Fall and Spring. Differential Tuition: \$100.

**ES 4213. Conservation Biology. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 or BIO 3283, or equivalents. The class topics will include studying the nature of the biosphere, threats to its integrity, and ecologically sound responses to these threats. Also included will be the origin and preservation of biotic diversity, how the rich variety of plant and animal life around us arose, how it has been maintained by natural processes, and how we can prevent its destruction. (Same as BIO 4033. Credit cannot be earned for both ES 4213 and BIO 4033.) Generally offered: Spring. Differential Tuition: \$150. Course fee: DL01 \$75.

**ES 4223. Urban Wildlife Ecology. (3-0) 3 Credit Hours.**

Prerequisites: ES 3033 and ES 3042, or equivalents. Fundamentals of urban ecology, field methods including urban wildlife and human surveys, and urban wildlife management and conservation strategies. Generally offered: Fall of even years. Differential Tuition: \$150.

**ES 4233. Restoration Ecology. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 or BIO 3283, or equivalents. Applies ecological principles to the restoration of disturbed terrestrial, wetland, and aquatic ecosystems. Includes the restoration of soils and waterways, of flora and fauna, and of natural ecological processes such as plant succession and nutrient cycling. (Same as BIO 4323. Credit cannot be earned for both ES 4233 and BIO 4323.) Generally offered: Spring. Differential Tuition: \$150.

**ES 4243. Wildlife Ecology. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033. Major environmental factors affecting wildlife; structure, and behavior of wildlife populations; regional wildlife communities and their conservation. (Same as BIO 4053. Credit cannot be earned for both ES 4243 and BIO 4053.) Generally offered: Spring even years. Differential Tuition: \$150.

**ES 4253. Sources, Fate, and Transport of Chemicals in the Environment. (3-0) 3 Credit Hours.**

Prerequisites: ES 2013, ES 2023, and MAT 1093, or equivalents. Sources of chemicals in the environment. Processes regulating fate and transport of metals, organics, nutrients, salts, pathogens, and radionuclides in the environment. Generally offered: Fall and Spring. Differential Tuition: \$150.

**ES 4263. River Ecosystems. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 with a grade of at least a 'C-'. This course examines the physical, chemical, and biological factors that determine biodiversity and the structure and function of aquatic and riparian ecosystems. Key ecological and hydrogeomorphology concepts and their application to environmental concerns are covered. (Same as BIO 4263. Credit cannot be earned for both BIO 4263 and ES 4263.) Generally offered: Spring of even years. Differential Tuition: \$150.

**ES 4273. Fish Ecology. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 with a grade of at least a 'C-'. A study of the biotic and abiotic factors affecting the diversity and distribution of fishes, with a focus on North American freshwater fishes. This course will include (1) lectures and discussions covering patterns and processes in fish ecology; and (2) a collaborative research project covering computational techniques used in fish ecology. (Same as BIO 4273. Credit cannot be earned for both BIO 4273 and ES 4273.) Generally offered: Fall of even years. Differential Tuition: \$150.

**ES 4283. Plant-Soil-Microbe Interactions. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033 with a grade of at least a 'C-'. Restricted to students who have completed 60 or more hours. This course focuses on the microbial groups which live in soils and among plant species and methodologies used to understand their interaction. (Same as BIO 4283. Credit cannot be earned for both BIO 4283 and ES 4283.) Generally offered: Spring of odd years. Differential Tuition: \$150.

**ES 4293. Human Dimensions of Wildlife Management. (3-0) 3 Credit Hours.**

Prerequisite: ES 3033. This course will introduce students to the role that humans play in the management of wildlife and how people's knowledge, values, and behaviors influence conservation decisions. Students taking this course will develop an understanding of the social, political, and economical drivers of wildlife management. They will also explore ways to engage stakeholders in wildlife management through conservation tools and effective communication that considers human dimensions. An emphasis will be placed on working with private landowners, and in so doing train students to work in private landscapes where culture, society, politics, and economics often provide the context for management decisions. Generally offered: Spring even years. Differential Tuition: \$150.

**ES 4303. Principles of Wildlife Management. (3-0) 3 Credit Hours.**

Prerequisite: ES 4243. Ways of conserving desired numbers of animals for the overall best interests of society, be they aesthetic, ecological, economic, commercial, or recreational; includes management of endangered species, exploited species, wildlife communities in nature reserves, and wildlife pests. Generally offered: Spring even years. Differential Tuition: \$150.

**ES 4503. Introduction to Environmental Risk Assessment. (3-0) 3 Credit Hours.**

Prerequisite: ES 4183 with a grade of "C-" or better. This course will offer hands-on training in the primary areas of risk assessment (i.e., hazard identification, dose-response assessment, exposure assessment, and risk characterization). Generally offered: Fall of odd years. Differential Tuition: \$150.

**ES 4513. Advanced Environmental Risk Assessment. (3-0) 3 Credit Hours.**

Prerequisite: ES 4503 with a grade of at least a 'C-'. This course will offer hands-on training in the advanced areas of risk assessment (i.e., hazard identification, dose-response assessment, exposure assessment, and risk characterization). Generally offered: Spring of even years. Differential Tuition: \$150.

**ES 4911. Independent Study. (0-0) 1 Credit Hour.**

Prerequisites: Permission in writing (form available) from the instructor, the student's advisor, the Department Chair, and Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Generally offered: Fall, Spring, Summer. Differential Tuition: \$50.

**ES 4912. Independent Study. (0-0) 2 Credit Hours.**

Prerequisites: Permission in writing (form available) from the instructor, the student's advisor, the Department Chair, and Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Generally offered: Fall, Spring, Summer. Differential Tuition: \$100.

**ES 4913. Independent Study. (0-0) 3 Credit Hours.**

Prerequisites: Permission in writing (form available) from the instructor, the student's advisor, the Department Chair, and Dean of the College in which the course is offered. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Generally offered: Fall, Spring, and Summer. Differential Tuition: \$150.

**ES 4953. Special Studies in Environmental Science. (3-0) 3 Credit Hours.**

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Generally offered: variable. Differential Tuition: \$150. Course fee: DL01 \$75.

**ES 4963. Internship. (0-0) 3 Credit Hours.**

Prerequisite: Consent of the Undergraduate Advisor of Record. An opportunity for students to work in a setting that permits them to apply what they have learned in the formal instruction part of the program. Generally offered: Fall, Spring, Summer. Differential Tuition: \$150.